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FLYING-MACHINES.

By T. W. MATHER.

THE subject of my paper—flying-machines—in a general way, is of interest to everybody. But, to those who have given it more particular attention, it is not only interesting but fascinating, and a little dangerous. The pathway has been strewed with wrecks; and I fear there is a feeling prevalent that, after all, it leads nowhere in particular, unless it be to the almshouse or lunatic asylum.

Still, there are times when we heartily envy the birds their wonderful power. I remember in reading, I think, Mr. Wallace's book on the Amazons, that he was once standing on the shore of the mighty river, confronted by an impenetrable wall of green, concealing within itself doubtless no end of new plants and beetles; and when a gayly painted macaw came sailing lazily along and disappeared behind the tree-tops without any sort of trouble, he gave vent emphatically to the general wish to fly, and to a feeling of surprise that apparently so simple a problem should have remained so long unsolved.

I propose here to give an account of some of the attempts to fly that have been made in the past, and are now being made; and to try to explain the principles involved, and why success has not been achieved.

The old Greeks and Romans very sensibly appear to have been content to give the gods and birds and butterflies a monopoly of the air; for, excepting the story of Dædalus and Icarus, little mention has been made by classical writers of attempts to fly, or of flying-machines.

Dædalus, it seems, had killed a man in Athens, and with his unfortunate son fled to Crete, where King Minos very properly detained him; but, determined to escape, he made wings of feathers cemented with wax, and, instructing Icarus to fly neither too high nor too low, but to closely follow him, launched himself into the air, and took a bee-line for Greece. The young man, however, was ambitious, and, flying too near the sun, the wax melted, and he perished in the sea—a warning to future generations.

After Dædalus, we next hear of Archytas of Tarentum in Sicily, a famous geometrician who lived about 400 years B. C. He is credited with a dove made of wood, so contrived, we are told, "as by certain mechanical art and power to fly; so nicely was it balanced by weights and put in motion by hidden and inclosed air." One is surprised at the amount of talk and speculation that these few words have caused. If the dove were put in motion by inclosed air, then probably it was constructed on the principle of a balloon. If so, then of course the air must have been heated; or, better, since wood will crack and warp from heat, not unlikely a light gas was used; and since hydrogen is light, possibly hydrogen; and if so, how did Archytas prepare it? Others seriously try to throw ridicule on the whole affair, saying that a wooden dove could not possibly get support in such a way—that necessarily it would be too large and heavy, and that the material would not stand the strain, and so on.

For my own part, however, I think that old Lauretus Laurus had the true theory and explanation. He says that "the shells of hen's eggs, if properly filled, and well secured against the penetration of the air, and exposed to the solar rays, will ascend to the sky, and sometimes suffer a natural change; and if the eggs of the larger description of swans, or leather balls, stitched with fine thongs, be filled with niter, the purest sulphur, quicksilver, or kindred materials, which rarefy by their caloric energy; and if they externally resemble doves they will easily be mistaken for flying animals.

"If we should desire to give aërial motion to a wooden and ponderous machine, we must apply fire. Should there be any apprehension of the dove being burned, it can be covered over with some incombustible coating, and tubes of tin introduced, so that the fire may be kept alight in its bosom without injury to it. . . . To prevent the crackling of flames, and the emission of sparks, the powder may be deprived of force by the mixture of ochre and butter. . . . An artificial throat may be formed to change the crackling of the flames into an imitation of the cooing of a dove. Tubes could have been easily" (and probably were) "constructed to ascend one after the other at convenient intervals, so that the bird would apparently be endued with life."

After Archytas, we hear little or nothing of flying-machines until the middle ages. Then the astrologers and alchemists and witches, in league with the evil-one on the one hand, and the friars and monks helped by good spirits on the other, did many wonderful things. The competition was strong. To simply fly was a mere *bagatelle*, a ready means to the sinful or good end in view. The broomstick took a pre-eminent position as a flying-machine. What a pity it is that our ancestors should have so persistently fought against and finally succeeded in surpressing the broomstick! What could be more simple and effective? Perhaps by proper treatment the witches might have been persuaded to instruct the rest of the world in its use. In those days, dragons and magicians and good and evil spirits made out-of-doors at night rather dangerous, and good people remained at home, with holy water on hand for an emergency. Here is an example from Remigius. Says he: "There is no doubt the following will be considered incredible by all and ridiculous by many; yet I can aver that two hundred persons testified to its truth. On regular and stated days these people assembled in a crowd on the banks of some lake or river, secluded from the observation of passers-by; and there they were in the habit of lashing the water with wands received from demons, until such time as vapors and mists were produced in large quantities, and with these they were wont to soar on high. The exhalations thus provoked condensed themselves into thick and darkling clouds, agitated and swept the heavens, assisted in their atmospheric war by the evil spirits whom they wrapped in their folds, and at length in a hail-storm smote the earth in their fury. . . . Salome and Dominica Zabella, however, add that, before they thus agitated the water, they were in the practice of throwing into it an earthen pot, in which a little previous a demon had been inclosed, together with some stones of such size as they wished the hail to be. . . . Decker Maygeth states that he and his confederates in crime used to receive candles from a demon of an azure color, and sail with them some distance from the margin of the lake, hold the light downward and let it drop freely into the water; that after that they scattered and spread some medicinal powder over the surface; that they then, with black rods, bestowed on them by demons, most vehemently lashed the waters, accompanying the action with a repetition of incantations to produce the desired results. Then the sky became overcast with clouds, and discharged torrents of rain and hail on those localities which they had pointed out." This incantation, Remigius says, "is not an invention of modern ages. It is not the invention of old hags whose mental powers were depraved by demons, or perverted by visions or dreams. It was practiced by men of keen intellects and acute investigation, who minutely observed, critically examined, and deliberately adopted their convictions."

Here is a description, according to Kircher, of a flying-machine invented by one of the fathers of the Church: Some of the fathers in India had been "cast into prison, and while they continued ignorant of any means of effecting their liberation, some one, more cunning than the rest, invented an extraordinary machine, and then threatened the barbarians, unless they liberated his companions, that they would behold in a short time some wonderful portents and experience the visible anger of the gods. The barbarians laughed at the threat. He then constructed a dragon of the most volatile paper, and in this inclosed a mixture of sulphur, pitch, and wax, and so artistically arranged all his materials that when ignited it would illumine the machine and exhibit this legend—'*The wrath of God.*' The body being formed and the ingredients prepared, he affixed a long tail, and committed the machine to the heavens. Favored by the wind, it soared aloft toward the clouds. The spectacle was terrific. The barbarians beholding it were smitten with the greatest astonishment and fear. . . . Thereupon without delay," says Kircher, "they threw open the gates and suffered the prisoners to go forth in peace."

In the middle ages, anybody at all distinguished by knowledge of science was credited with the art of flying, and indeed in many cases did not scruple to claim it. Albertus Magnus was one of these, but refused to give particulars to the world at large. He tells us, however, how to make thunder. Says he: "Take one pound of sulphur, two pounds of willow carbon, and six pounds of rock-salt, ground very fine in a marble mortar; place where you please in a covering made of flying-papyrus to produce thunder. The covering, in order to ascend and float away, should be long, graceful, and well filled with this powder; but to produce thunder the covering should be short and thick, and half full."

Roger Bacon, an eminent philosopher of the thirteenth century, also claimed to have knowledge of the art of flying, but believed also in the wisdom of silence concerning the details. But in his writings we find flashes of real light. He speaks of the possibility of constructing engines of great power to traverse land and sea; and seems to have been the first to have tolerably clear ideas of the principles involved in the construction of balloons. He describes a large hollow globe of copper or other suitable metal wrought extremely thin. It must then, he says, "be filled with ethereal air or liquid fire, and then be launched from some elevated point into the atmosphere, where it will float like a vessel on the water."

In his day the air was supposed to have a well-defined upper limit, like the water.

Friar Bacon too has been credited with the invention of gunpowder. He was of course accused of holding communion with the devil. Good Pope Nicholas placed his writings under a ban, and his wings were effectually clipped.

Shortly after his time, the project of training up children from infancy to fly received a good deal of attention, and, if we can trust the accounts, considerable progress was made, for it is said that, by combined running and flying, individuals could skim over the ground with great rapidity.

Regiomontanus, a famous mathematician, is said like Archytas to have formed an artificial dove, which flew out to meet the Emperor

Charles V at his public entry into Nuremberg. But, if this is true, the dove must have survived its inventor for at least twenty years. Then we are told of a monk who attempted a flight with wings from the top of a tower in Spain. He broke his legs, and was afterward burned as a sorcerer. Another similar trial was made from St. Mark's steeple in Venice; another in Nuremberg; and so on—legs or arms were usu-

FIG. 1.—THE FLYING-MAN (Rétif de la Bretonne's idea). (From an old number of "Scribner's Magazine.")

ally broken, occasionally a neck. In the sixteenth century we read of a certain Italian who went to the court of James IV of Scotland, and attempted to fly from the walls of Stirling Castle to France. His thigh was broken; but, as a reason for the failure, he asserted that some of the feathers used in constructing his wings were from barn-yard fowls, with a natural affinity for the dung-hill; whereas, if composed solely of eagle-feathers, they would have been attracted to the air. However, he does not appear to have carried the experiment further.

Many other trials have there been of the same character. The results were generally discouraging, but men can always be found ready to risk life and limb in striving to attain something much less important than the art of flying; without a knowledge of the principles involved, ignorant of the nature of the atmosphere, without machinery or power, fettered by a superstition that looked upon all learning outside of the Church as coming from the prince of darkness, it was a struggle in the dark—brave but hopeless.

Still, those old fellows were quite as reasonable in their attempts as many of our inventors are now. In looking through Patent-Office reports, we shall find devices only slightly different in detail from those tried five hundred years ago.

One of our illustrations shows the plan proposed by Rétif de la Bretonne away back in the dark ages; and another an apparatus patented in this country in 1872. It is only one of numbers of the same sort. Rétif had an advantage, in that he carried a lunch-basket and umbrella, and did not need so many ropes and spars; but otherwise the later arrangement seems equally good.

In 1783 the Montgolfiers invented the balloon. Friar Bacon, as we have seen, had speculated upon the possibility of such a construction. In 1670 Francis Lana, a Jesuit, had described an apparatus which, although impracticable in so far that it could not be built, nevertheless was correct in principle. The same idea had occurred to others; and there are even shadowy accounts of actual ascents. But to the Montgolfiers certainly belongs the honor of first actually building and bringing the balloon before the public as an accomplished fact. They used hot air only, but the substitution of hydrogen gas by Professor Charles speedily followed, and in a few years the balloon was made as perfect, excepting in a few details, as it is now.

It would be difficult to describe the excitement which followed this invention. The most extravagant hopes and anticipations were entertained. The problem had been solved. The birds and insects would no longer have a monopoly. Every gentleman would have a balloon hitched to his gate-post, or, wafted along by summer breezes, would look down in luxurious pity upon the poor plodders. Sails and rudders were to be used as on ships to direct the course. Regular lines of aërial passenger and mail coaches were to be established. There seemed no limit to the possible speed. Rome, or St. Petersburg, or even America, might be reached in a few hours, and for the comfort of travelers the arrangements proposed went far ahead of our palace-cars. Floating hospitals were to be built; methods of warfare would need to be entirely reorganized; and England's boasted supremacy on the sea would be of no avail, unless she also maintained supremacy in the air.

Fig. 2.—The Modern Flying-Man. (Taken from United States Patent-Office Reports.)

Of course an invention of such importance could not escape condemnation. Balloons were manifestly contrary to the will of Divine Providence, for, if it had been intended that man should fly, wings would have been given to him. Moreover, the barriers of virtue and morality would be broken down by permitting aëronauts to descend into gardens and balconies; and, above all, the boundaries of empires would be practically annulled, and nations in consequence engage in continual war.

Well is it, then, for humanity that balloons have not proved a very great success. Many extensive voyages and many interesting observations have been made; but as a flying-machine the balloon has no place. It is the servant of the air, not the master. It must obey a will, pitiless, fickle, sometimes kind, but never trustworthy. The expectation that headway could be made against the wind by means of sails and rudders had no basis in sound theory or sense. A sailing-ship is immersed in two fluids of widely differing densities, and its sail is only effective because the water, while supporting, at the same time allows the vessel to move more readily in one direction than another.

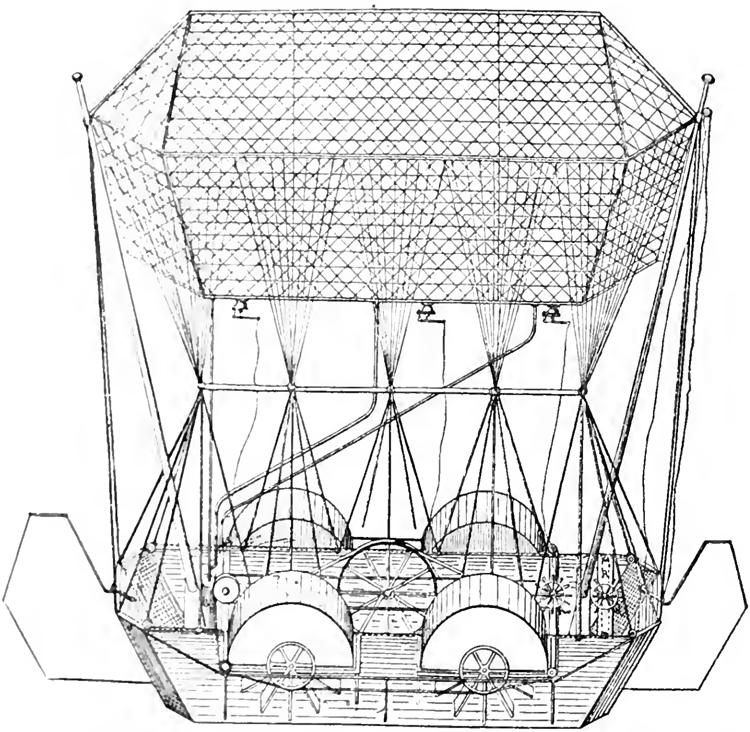

Fig. 3.—Sullivan's Flying-Machine. (Taken from United States Patent-Office Reports.)

A balloon, on the other hand, is totally immersed in an ocean of air, and being of the same weight bulk for bulk, and subject to no external forces, must necessarily follow the slightest current. One might as well attempt to steer a boat, swept along by a great stream, without wind or oar. It forms an integral part of the current itself. It is a thistle-down blown by an autumn gale.

Of course we may provide our balloon with wings or propeller, and fly as the birds fly. This has been and continues to be a favorite combination with our inventors. One patented in this country in 1880 has been chosen as an illustration. The balloon, oblong in shape and divided for safety into compartments, supports a car containing the propelling machinery, and also a gas-generator to make up such loss of hydrogen as may occur. Two immense rudders steer the machine. It is propelled by four paddle-wheels, which would act, one would think, very much as the wheels of our river-steamers would act, if totally immersed in the water, and would be about as likely to drive the balloon backward as forward.

Generally, however, in machines of this class the propeller is one gigantic screw, or a number of screws, and the balloons have a variety in shape and grouping which is quite remarkable.

It is strange that people have not realized that a thing necessarily so big and light as a balloon can not be made strong and durable enough to stand the pressure of the wind at comparatively low velocities. Floating with the current, the velocity would have no destructive effect; but brought into opposition to this current, or forced at any great speed through the air, the resistance would be much greater than a silk bag could safely stand.

It may be well here to refer to a table giving the relation of pressure to velocity of air, experimentally determined and verified time and again—results very important in the study of flying and flying-machines:

VELOCITY OF THE WIND.		Pressure on one square foot.	Character of the wind.
Miles per hour.	Feet per second.	Pounds.	
1	1·47	0·005	Hardly perceptible.
5	7·33	0·123	Gentle wind.
10	14·67	0·492	Pleasant brisk wind.
15	22·00	1·107	
20	29·34	1·968	Very brisk.
25	36·67	3·075	
30	44·01	4·429	High winds.
35	51·34	6·027	
40	58·68	7·873	Very high.
45	66·01	9·963	
50	73·35	12·300	Tempest.
60	88·02	17·715	Great storm.
80	117·36	31·490	Hurricane.
100	146·70	49·200	Cyclone.
150	......	......	Sometimes reached.

Now let us suppose that a balloon only forty feet in diameter should resist the pressure of wind blowing at the rate of twenty miles an hour, or, what is the same thing, that the balloon should be traveling through still air at this speed. The surface presented to the wind would be about twelve hundred square feet, and the pressure on each square foot, from our table, would be 1·9 pound, and the total pressure over a ton. A calculation is hardly necessary to show that such a pressure, acting constantly upon our silk, would be likely to rupture it; and when we consider that sudden gusts might readily increase the pressure five-fold, it will be admitted that *terra firma* would be decidedly safer, if less exciting.

More than all this, balloons as hitherto constructed are at best but temporary affairs, quickly losing their gas and buoyancy, expensive and unwieldy, and, however valuable for certain kinds of work, must be considered as simply floating, not flying machines. If we expect to gain the respect of the birds or butterflies, we must go to work in a much less clumsy way.

In the excitement following Montgolfier's invention, simple flying-machines dropped out of sight almost entirely, and it was only after a long series of disappointing trials that the old ideas came to the surface again. The balloon craze, however, brought about a more careful study of aëronautics generally; but at the same time there has been and is a strong current of misguided thought and invention, particularly to be noticed in our Patent-Office reports.

Inventors of flying-machines, as a rule, belong rather in a lower class. Just as we still find old-new arrangements for producing perpetual motion, so in the attempts to fly the old story is repeated. The perpetual-motion man is likely also to know just how to make a successful flying-machine. He only lacks the means. Still, particularly in England and on the Continent, many able men have been working intelligently, perseveringly, quietly. Before building a flying-machine they have thought best to study the examples Nature has provided, thinking that, while we need not necessarily imitate the mechanism, we may in this way get a better idea of the principles and action involved.

The broad principle governing either natural or artificial flight is quite simple, but the difficulty of applying it very great. Our flying-machine, one that is much heavier than the air, and depending entirely upon its own power, in the first place, must be able by acting on the air to lift itself, and, while maintaining a position at any desired height, to propel itself forward. It must be prepared to encounter and take advantage of, and overcome currents of air sometimes hardly perceptible, sometimes perhaps a roaring gale—currents, too, not unlikely to suddenly change both in direction and velocity. It should be able to fly continuously for a long while, and should be tolerably safe.

On the water, if the machinery gives out, we can float or swim; but in the air any little difficulty of the sort would be likely to end unpleasantly. And even if, like a parachute, the machine could be made to drop slowly, in a brisk wind the final landing-place would for a while be a matter of uneasy conjecture.

It may easily be understood, then, that the problem is not a simple one, and yet, to a person watching, for example, the flight of a flock of gulls following in the wake of a steamer, the exquisite ease and grace and apparent simplicity of the movement are very striking. Sweeping around in circles, occasionally elevating themselves by a few flaps of the wings, they glide down and up the aërial inclines without apparently any effort whatever. But a close observation will show that at every turn the angle of inclination of the wings is changed to meet the new conditions. There is continual movement with power—by the bird it is done instinctively, by our machine only through mechanism obeying a mind not nearly so well instructed.

The study of the flight of birds and insects has of late years received a great deal of attention, and, in a general way, the motions of the wings are fairly well understood. We could probably very closely imitate these motions, but the question at once arises, in doing so, would we be applying our power in the most effective way? While somewhat similar, the movement and construction of the wings of flying creatures vary considerably. What is best for a heavy body with short wings is by no means best for a light body with long wings; nor does a sea-bird, constantly on the wing, but perhaps not a rapid flier, fly in the same way as a pigeon or humming-bird; and, in any particular case, it does not necessarily follow that Nature has provided the most efficient apparatus; or, in other words, that the power the bird possesses could not be utilized more effectively. Nature can not always be trusted. We can study and understand her laws, but she does not pretend to apply them on economical principles. Fish and marine animals swim in a great variety of ways, they have all sorts of propelling arrangements, but there can be no doubt that a screw-propeller is vastly more efficient than any of them; and why should we try to copy the motions of a bird's wing any more than those of a fish's tail? The motions are very complicated in any case, and our machine, imitating them, would be complex and liable to get out of order. And one can not help thinking that we are about as likely to make a steam road-wagon by imitating the action of a horse, as we are to make a practicable flying-machine by copying the motions of a bird. The desired results can probably be obtained in a much more simple and effective way.

Still, the study of flying creatures has brought out many interesting and suggestive facts, and has given us, too, some encouragement.

In the first place, we notice that all birds are heavy, and that the expanse of wing generally diminishes in proportion to the increase of weight. The following is a table prepared by M. Lucy, showing this very clearly:

Table giving the Expanse of Wing-Surface for each Pound of Weight.

	Square feet.
Gnat	48·9
Dragon-fly	21·65
Cockchafer	5·1
Sparrow	2·7
Pigeon	1·2
Vulture	0·82
Australian crane	0·41

We see that the gnat, one of the lightest of insects, has an expanse of wing of no less than 48·9 square feet for each pound of weight, while the heavy cockchafer has only 5·1 square feet for each pound. With birds, the sparrow has 2·7 square feet of wing-surface for each pound of weight, while the great Australian crane has only 0·41 of a square foot, and yet this bird undertakes remote journeys, and, the eagle excepted, flies higher, and keeps on the wing longest, of all the travelers.

It would appear, then, that our flying-machine, while heavy, need not necessarily have a very broad expanse of flying surface. Indeed, paradoxical as it may seem, weight is really an essential feature. Set in motion by muscular effort, the weight of a bird acts somewhat like the fly-wheel of an engine: the power is stored up during the downward stroke of the wing, to be given out again on its upward stroke, and probably it is weight also that enables the bird to successfully combat and take advantage of the force of the wind. It is noteworthy that all sailing-birds, like the hawk or vulture, have comparatively heavy bodies. The magnificent albatross, in rising from the water, is said to beat the air with great energy, but, when fairly launched, in a brisk gale, will sweep around in broad circles for hours together, hardly ever deigning to flap a wing. Darwin, in his "Voyage of the Beagle," speaks of watching the condor sailing in a similar way at a great height, without, so far as he could notice, any flapping action whatever.

At the same time, it is hard to understand how such a condition of affairs could exist. The condor's wings, inclined to the wind, have been compared to a kite, and if there were a string stretching from the bird to some fixed point, the whole thing would be clear; but every boy knows to his cost that, if the string slips or breaks, the kite quickly seeks some other point of support—probably a telegraph-wire. But Professor Pettigrew has suggested that the string is the invisible one representing the attraction of gravitation, and that "the string and the hand are to the kite what the weight of the flying creature is to the inclined planes formed by its wings." This, however, does not make the matter much clearer, for the force of gravity acts in vertical lines, and a vertical kite-string, with the kite flying directly overhead, is a thing, it is safe to say, no boy ever saw. Why should not our bird drift with the wind unless he uses some muscular effort to overcome its force or to keep himself from falling?

Once elevated, he can utilize his weight in a number of ways. A body will naturally fall along a line of least resistance, and if the front edge of the wings be tipped slightly downward the bird will glide forward while falling, gaining velocity and momentum; and then, by reversing the inclination of the wings, he can again glide up an aërial incline until this stored-up energy has been expended. But the resistance of the air must be overcome, and there must be continual loss from the imperfect sustaining power of the wings.

We shall see presently that the force of the wind can be utilized to a certain extent to make up these losses, but still some muscular effort should be required. If our vulture or albatross would only occasionally deign to flap a wing, all would be well. His obstinacy is very perplexing.

Leaving the birds to their own peculiar devices, let us now consider what principles should guide us in constructing a flying-machine.

In the first place, by acting on the air, the machine should be able to lift itself from the ground; and, leaving out of account small models, this is a preliminary no one appears so far to have succeeded in. Many pictures may be seen of flying-machines booming along through the air with all sails set, passengers evidently happy, some serenely smoking, others promenading the deck in the usual way, with perhaps a couple behind the wheel-house; but a representation of a machine just on the point of starting out is not to be met with.

In order to produce an upward pressure or reaction, the wings or propeller acting on the air evidently should drive it downward. Suppose now that our machine weighs 600 pounds, and that it has the same propelling surface in proportion to its weight as the Australian crane, we should then need about 246 square feet, and a pressure of 2·4 pounds acting upward on each square foot would lift it from the ground.

Referring again to the table giving the relation between wind velocity and pressure, we notice that a pressure of 2·4 pounds would be occasioned by a velocity of about twenty-two miles an hour.

If, then, we should cause our propeller—be it a screw or wings, or any other form—to drive downward a current of air at this rate, the cross-section or area of the current being 246 square feet, the total upward reaction would be great enough to raise the machine.

Of course, for any other proportion of wing-surface to weight, our table would give other results; or if the air is already in motion, it will tell us what increase of velocity should be given to produce the desired pressure.

The results given in the table can also be readily found in a purely theoretical way, and they seem so important that it is a wonder investigators have given them little or no attention.

A machine possessing weight can fly only by doing something to the air. It must put the air in motion, and it can be shown that the amount of this motion will be a measure of the work done and reaction obtained.

If air is already in motion, we can not utilize its force, not wishing to drift along, except by changing in some way its velocity.

Granting all this, our table or formula will tell us, not only what volume of air must be used to gain the desired reaction or motion, but also the *least power necessary*. Knowing the weight of and velocity impressed upon the air, downward or in any other direction, it becomes an easy matter to determine the power.

For example, in the practical case just considered, to lift the machine from the ground would require an expenditure of at least eighteen horse-power. This is the least power that would do the work —the actual power would depend entirely upon the efficiency of the propeller.

Having at last succeeded in getting away from the ground, we wish to fly in any direction—to set the birds an example of how the thing ought really to be done.

Here, again, we must apply the principles just announced. To go forward, the air must be driven aft. Knowing the speed proposed, our table will give us at once the resistance for each square foot; and knowing the size or bulk of our machine, we can readily estimate the power required.

The management of the wind unquestionably will be a very important factor in the construction of a flying-machine; indeed, it may be considered the most troublesome part of all. Properly handled, the wind might be made a useful servant, otherwise a dangerous master.

The only plan that suggests itself is through the use of an inclined plane. Here, at any rate, we must imitate the birds.

My attention was not long ago called to an article on Aëronautics, in the Proceedings of the New Zealand Institute for 1878, and in it was a table from experiments by Mr. Skye, giving the lifting power of the wind, blowing at the rate of twenty-three miles an hour upon a plane surface, one square foot in area, inclined at various angles. These figures lead to some very surprising and interesting results:

Angle plane makes with wind.	Lifting force, in pounds.	Drifting force, in pounds.	Ratio between the two.
5°	1·13	0·23	4·91
10°	1·43	0·67	2·14
20°	1·65	0·92	1·8
30°	1·83	1·35	1·36
40°	2·00	1·73	1·15
50°	1·80	2·07	0·87

It will be seen from the second column that while the greatest lifting effect occurs at about an angle of 40°, even at so small an angle as 5° it is still considerable. The third column gives values for the corresponding horizontal pressures; that is, the force which tends to move the plane in the direction of the wind. The fourth column gives the ratio between the two.

It will be seen that the drifting force diminishes at a much faster rate than the lifting force, as the angle of inclination of the plane becomes less.

Consider again the flying-machine weighing 600 pounds, and suppose that, in addition to the propeller, we furnish it with an inclined plane having the same area, or, perhaps after the manner of birds, make the propeller act also as an inclined plane ; and let it be inclined five degrees, with the wind blowing at the rate of twenty-three miles an hour. Then the table shows us that the total lifting force due to the wind would be 278 pounds, leaving 322 pounds to be supported in some other way. The horizontal or drifting force would be 0·23 pounds on each square foot, or only 56 pounds altogether. To counteract this, let us make our propeller act as a kite-string by sending backward the air at an increased velocity. Our other table tells us how great this velocity should be, and makes the necessary power amount to only about half a horse-power. To support the balance of the weight, we should need also to send downward a current of air, involving an additional expenditure of about seven horse-power.

Combining the two, we get this extraordinary result, that while nearly nineteen horse-power was necessary to lift our machine from the ground, it could hold its own in a breeze of twenty-three miles an hour with an expenditure of only seven and a half horse-power.

No account has been taken of the wind blowing against dead surfaces, such as the body of the bird or machine. This, of course, would depend upon the shape. A bird's body is long and narrow, cleaving the air without great resistance, and a flying-machine should be fashioned similarly.

Other losses have not been considered, but still the broad result holds that it is possible in this way to utilize part of the energy stored up in the wind. The accuracy of the results will depend upon that of Mr. Skye's table ; but if future experiment should verify it, we can understand why it is that the albatross, and wild-duck, and heavy birds generally, while rising with great difficulty, when once up keep on the wing with so much apparent ease.

However, there is still the necessity for a kite-string of some sort. There is a force tending to carry the bird along with the wind which must be overcome somehow, and I still fail to understand how the albatross can sail in the air indefinitely without some muscular effort.

From Mr. Skye's table, in connection with the other, we get this important practical result—that in a flying-machine, properly constructed, the greatest power required will be that necessary to lift it from the ground ; and that once off, up to a certain limit, the stiffer the breeze the better.

The efficiency of a propeller of any sort will depend not only upon its area, but also upon its ability to send the air away in parallel streams. If we wish to go forward, the air must be driven aft, and a forced current in any other direction will at best give us back but a fraction of its energy. Ordinary screw-propellers have not proved very effective, for the reason, probably, that revolving at great speed, they send off a large amount of air tangentially.

What, now, should be the mechanical construction of a successful flying-machine? How should it be built? In what way should the power be applied? I have tried to make clear what seem to me the principles involved, but the best method in which to apply them can only be found by patient and intelligent study and experiment. Many men have been and are now working at the problem, and that it will be eventually solved seems certain. A bird's muscles, while strong, are not as strong as steel, and while his power in proportion to his weight is great, we can exceed it; and let us not admit that we can not equal his intelligence in applying it.

One of our illustrations shows the flying-machine invented by Mr. Henson in England in 1842, and deserves mention as being the first

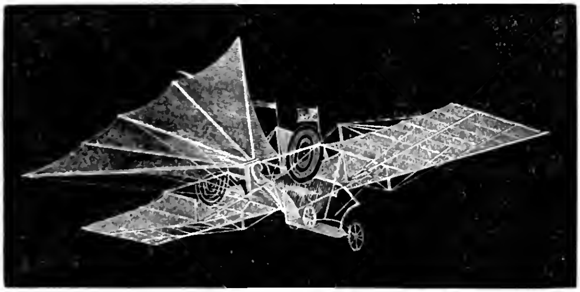

Fig. 4.—Henson's Aërostat.

of importance designed to fly without the aid of muscular power. The chief feature was the very great expanse of its sustaining planes, which were larger in proportion to the weight than in many birds. The machine advanced with its front edge a little raised, and the air acting upon the lower surface, when the proper speed had been attained, was expected to lift and sustain it. This speed at the start-off was to be got by running down an inclined plane or hill, and the object of the screw-propeller was simply to keep up the motion. It is unnecessary to say that this machine did not work, and yet Henson evidently had a glimmering of what is required. He introduces the inclined plane and propeller, but does not apply them in a practical way. Such a machine, of course, would be completely at the mercy of the winds; and while he might find a convenient hill to roll down in order to get the required velocity, in coming to earth again there might be trouble.

Landell's flying-machine, invented in 1863, was also provided with an extensive aëro-plane, but differs in having screws acting vertically to sustain the machine in addition to those for driving it forward. Capping all are two parachutes, intended to open and prevent a sudden fall in case of accident. There are four sets of blades on each vertical screw-shaft, on the principle, one would think, that if one set would be a good thing, four sets would be four times as good. They would be likely to act somewhat like four screw-propellers, one behind the other, on an ocean-steamer. The mechanism was to be driven by a steam-engine. The dark object suspended below may be ballast to counteract any superfluous energy of the steam.

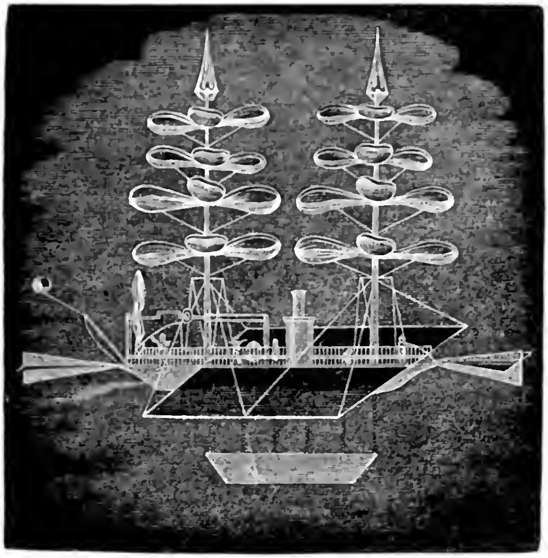

FIG. 5.—LANDELL'S FLYING-MACHINE.

In 1868 Mr. Stringfellow built and exhibited a model of a flying-machine at the Crystal Palace, in London, where it took a prize. There are three aëro-planes, one above the other, with a broad tail behind. As in Henson's machine, no provision was made for lifting it

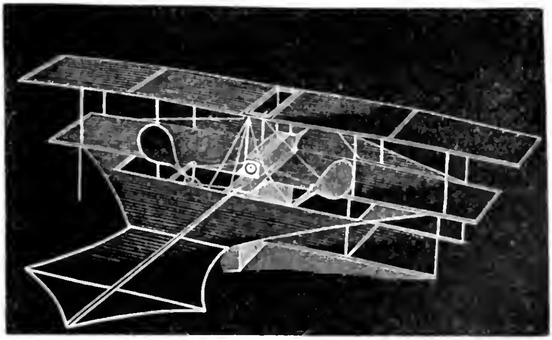

FIG. 6.—STRINGFELLOW'S FLYING-MACHINE.

from the ground, the power being applied simply to produce or keep up horizontal velocity, the reaction of the air against the inclined planes serving to sustain the weight.

At the exhibition the model ran down an inclined wire, but refused to rise into the air. It weighed only twelve pounds, including an engine exerting one third of a horse-power, boiler, water, and everything. Of course, even if the model had been a success, no large machine constructed in such a way could be of practical value.

The machine designed by Mr. Moy in 1874 was somewhat similar to Henson's and Stringfellow's. There are two inclined planes, one behind the other, and two horizontal screws. The necessary speed to lift the machine was to be obtained by a preliminary run along the

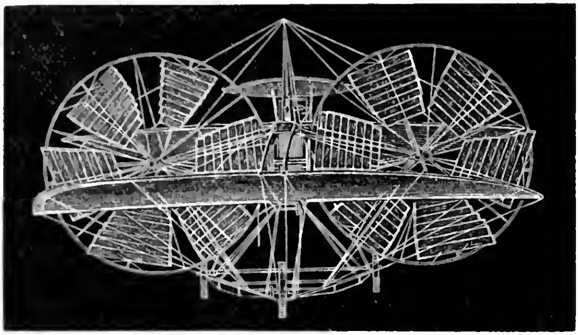

Fig. 7.—Moy's Aërial Steamer.

ground on the wheels underneath. In coming to earth again we should only need to look out for some favorable locality, strike tangentially, and the resistance of the wheels over stones, fences, and the like would speedily bring us to rest.

These are the more important inventions of this class—that is, self-raising and self-propelling machines—and it must be confessed the results are far from encouraging. M. Pénaud and others have constructed flying models, but on too small a scale to be of much practical importance.

But still there are the birds; they completely refute the arguments of those who say, "It is impossible to build a successful flying-machine."

MODERN SCIENCE AND MODERN THOUGHT.*

By S. LAING, M. P.

LIV.

Oh yet we trust that somehow good
  Will be the final goal of ill,
  To pangs of Nature, sins of will,
Defects of doubt, and taints of blood;

That nothing walks with aimless feet;
  That not one life shall be destroyed,
  Or cast as rubbish to the void,
When God hath made the pile complete;

* From Chapter VII of a work, under this title, published by Chapman & Hall, London, 1885.

That not a worm is cloven in vain;
  That not a moth with vain desire
  Is shriveled in a fruitless fire,
Or but subserves another's gain.

Behold, we know not anything.
  I can but trust that good shall fall
  At last—far off—at last, to all,
And every winter change to spring.

So runs my dream: but what am I?
  An infant crying in the night;
  An infant crying for the light;
And with no language but a cry.

LV.

The wish, that of the living whole
  No life may fail beyond the grave,
  Derives it not from what we have
The likest God within the soul?

Are God and Nature then at strife,
  That Nature lends such evil dreams?
  So careful of the type she seems,
So careless of the single life;

That I, considering everywhere
  Her secret meaning in her deeds,
  And finding that of fifty seeds
She often brings but one to bear,

I falter where I firmly trod,
  And falling with my weight of cares
  Upon the great world's altar-stairs
That slope through darkness up to God,

I stretch lame hands of faith, and grope,
  And gather dust and chaff, and call
  To what I feel is Lord of all,
And faintly trust the larger hope.

LVI.

"So careful of the type?" but no.
  From scarpèd cliff and quarried stone
  She cries, "A thousand types are gone:
I care for nothing, all shall go.

"Thou makest thine appeal to me:
  I bring to life, I bring to death:
  The spirit does but mean the breath:
I know no more." And he, shall he,

Man, her last work, who seemed so fair,
  Such splendid purpose in his eyes,
  Who rolled the psalm to wintry skies,
Who built him fanes of fruitless prayer,

Who trusted God was love indeed,
  And love Creation's final law—
  Though Nature, red in tooth and claw
With ravine, shrieked against his creed—

Who loved, who suffered countless ills,
  Who battled for the True, the Just,
  Be blown about the desert dust,
Or sealed within the iron hills?

No more? A monster then, a dream,
  A discord. Dragons of the prime,
  That tare each other in their slime,
Were mellow music matched with him.

O life as futile, then, as frail!
  O for thy voice to soothe and bless!
  What hope of answer, or redress?
Behind the veil, behind the veil.

Tennyson, *In Memoriam.*
(*By kind permission of* Lord Tennyson.)

These noble and solemn lines of a great poet sum up in a few words what may be called "the Gospel of Modern Thought." They describe what is the real attitude of most of the thinking and earnest minds of the present generation. On the one hand, the discoveries of science have so far established the universality of law, as to make it impossible for sincere men to retain the faith of their ancestors in dogmas and miracles. On the other, larger views of man and of history have shown that religious sentiment is an essential element of human nature, and that many of our best feelings, such as love, hope, conscience, and reverence, will always seek to find reflections of themselves in the unseen world. Hence faith has diminished and charity increased. Fewer believe old creeds, and those who do, believe more faintly; while fewer denounce them, and are insensible to the good they have done in the past and the truth and beauty of the essential ideas that underlie them.

On the Continent, and especially in Catholic countries, where religion interferes more with politics and social life, there is still a large amount of active hostility to it, as shown by the massacre of priests by the French Communists; but, in this country, the old Voltairean infidelity has died out, and no one of ordinary culture thinks of denouncing Christianity as an invention of priestcraft. On the contrary, many of our leading minds are at the same time skeptical and religious, and exemplify the truth of another profound saying of Tennyson:

"There is more faith in honest doubt,
Believe me, than in half the creeds."

The change which has come over modern thought can not be better exemplified than by taking the instance of three great writers whose works have produced a powerful influence—Carlyle, Renan, and George Eliot. They were all three born and brought up in the very heart of different phases of the old beliefs—Carlyle, in a family which might be taken as a type of the best qualities of Scottish Presbyterianism, bred in a west country farmhouse, under the eye of a father and mother whom he loved and revered, who might have been the originals of Burns's "Cotter's Saturday Night," or the descendants of the martyrs of Claverhouse. His own temperament strongly inclined to a stern Puritanical piety; his favorite heroes were Cromwell and John Knox; his whole nature was antipathetic to science. As his biographer, Froude, reports of him, "He liked ill men like Humboldt, Laplace, and the author of the 'Vestiges.' He refused Darwin's transmutation of species as unproved; he fought against it, though I could see he dreaded that it might turn out true." And yet the deliberate conclusion at which he arrived was that "he did not think it possible that educated honest men could even profess much longer to believe in historical Christianity."

The case of Renan was equally remarkable. He was born in the cottage of Breton peasants of the purest type of simple, pious, Catholic faith. Their one idea of rising above the life of a peasant was to become a priest, and their great ambition for their boy was that he might be so far honored as one day to become a country *curé*. Young Renan, accordingly, from the first day he showed cleverness, and got to the top of his class in the village school, was destined for the priesthood. He was taken in hand by priests, and found in them his kindest friends; they sent him to college, and in due time to the Central Seminary where young men were trained for orders. All his traditions, all his affections, all his interests, led in that direction, and yet he gave up everything rather than subscribe to what he no longer believed to be true. His conversion was brought about in this way: Having been appointed assistant to a professor of Hebrew, he became a profound scholar in Oriental languages; this led to his studying the Scriptures carefully in the original, and the conclusion forced itself upon him that the miraculous part of the narrative had no historical foundation. Like Carlyle, the turn of his mind was not scientific, and while denying miracles he remained keenly appreciative of all that was beautiful and poetical in the life and teaching of Jesus, which he has brought more vividly before the world in his writings than had ever been done by orthodox commentators.

George Eliot, again, was brought up in yet another phase of orthodox Christianity—that of middle-class nonconformist Evangelicalism. She embraced this creed fervently, and, as we see in her "Dinah," retained a keen appreciation of all its best elements. But as her intellect expanded and her knowledge widened, she too found it impossible to rest in the old belief, and, with a painful wrench from a revered father and loving friends, she also passed over from the ranks of orthodoxy. She also, after a life of profound and earnest thought, came to the conclusion recorded of her by an intimate friend and admirer, Mr. Myers:

"I remember how at Cambridge, I walked with her once in the Fellows' Garden of Trinity, on an evening of rainy May; and she, stirred somewhat beyond her wont, and taking as her text the three words which have been used so often as the inspiring trumpet-calls of men—the words *God*, *Immortality*, *Duty*—pronounced, with terrible earnestness, how inconceivable was the *first*, how unbelievable the *second*, and yet how peremptory and absolute the *third*. Never, perhaps, had sterner accents affirmed the sovereignty of impersonal and unrecompensing law. I listened, and night fell; her grave, majestic countenance turned toward me like a Sibyl's in the gloom; it was as though she withdrew from my grasp, one by one, the two scrolls of promise, and left me the third scroll only, awful with inevitable fates."

Such instances as these can not be the result of mere accident. As long as skepticism was confined to a limited number of scientific men, it might be possible to think that it was merely the exaggeration of a particular train of thought pursued too exclusively. But when science has become the prevailing mode of thought, and has been brought home to the minds of all educated persons, it is no longer possible to represent it as an exceptional aberration. And where the bell-wethers of thought lead the way, the flock will follow. What the greatest thinkers think to-day, the mass of thinkers will think to-morrow, and the great army of non-thinkers will assume to be self-evident the day after. This is very nearly the case at the present day; the great thinkers have gone before, the mass of thinkers have followed, and the still greater mass of non-thinkers are wavering and about to follow. It is no longer, with those who think at all, a question of absolute faith against absolute disbelief, but of the more or less shade of "faintness" with which they cling to the "larger hope."

This is nowhere more apparent than in the writings of those who attempt to stem the tide which sets so strongly against orthodoxy. They resolve themselves mainly into one long wail of "oh the pity of it, the pity of it!" if the simple faith of olden times should disappear from the world. They show eloquently and conclusively that science and philosophy can not satisfy the aspirations or afford the consolations of religion. They expose the hollowness of the substitutes which have been proposed, such as the worship of the unknowable, or the cult of humanity. They win an easy triumph over the exaggerations of those who resolve all the historical records of Christianity into myths or fabulous fulfillment of prophecies, and they wage fierce battles over minor points, as whether the first quotations from the Gospels are met with in the first or second half of the second century. But they nowhere attempt to grapple with the real difficulties, and show that the facts and arguments which converted men like Carlyle and Renan are mistaken facts and unsound arguments. Attempts to harmonize the Gospels, and to prove the inspiration of writings which contain manifest errors and contradictions, have gone the way of Buckland's proof of a universal deluge, and of Hugh Miller's attempt to reconcile Noah's ark and the Genesis account of creation with the facts of geology and astronomy. Not an inch of ground that has been conquered by science has ever been reconquered in fair fight by theology.

This great scientific movement is of comparatively recent date. Darwin's "Origin of Species" was only published in 1859, and his views as to evolution, development, natural selection, and the prevalence of universal law, have already annexed nearly the whole world of modern thought, and become the foundation of all philosophical speculation and scientific inquiry.

Not only has faith been shaken in the supernatural as a direct and immediate agent in the phenomena of the worlds of matter and of life, but the demonstration of the "struggle for life" and "survival of the fittest" has raised anew, and with vastly augmented force, those questions as to the moral constitution of the universe and the origin of evil, which have so long exercised the highest minds. Is it true that "love" is "Creation's final law," when we find this enormous and apparently prodigal waste of life going on; these cruel internecine battles between individuals and species in the struggle for existence; this cynical indifference of Nature to suffering? There are, approximately, 3,600,000,000 of deaths of human beings in every century, of whom at least twenty per cent, or 720,000,000, die before they have attained to clear self-consciousness and conscience. What becomes of them? Why were they born? Are they Nature's failures, and "cast as rubbish to the heap"?

To such questions there is no answer. We are obliged to admit that as the material universe is not, as we once fancied, measured by our standards and regulated at every turn by an intelligence resembling ours; so neither is the moral universe to be explained by simply magnifying our own moral ideas, and explaining everything by the action of a Being who does what we should have done in his place. If we insist on this anthropomorphic conception, we are driven to this dilemma. Carlyle bases his belief in a God, "the infinite Good One," on this argument: "All that is good, generous, wise, right—whatever I deliberately and forever love in others and myself, who or what could by any possibility have given it to me, but One who first had it to give? This is not logic; this is axiom."

But how of the evil? No sincere man looking into the depths of his own soul, or at the facts of the world around, can doubt that along with much that is good, generous, wise, and right, there is much that is bad, base, foolish, and wrong. If logic compels us to receive as an axiom a good author for the former, does not the same logic equally compel us to accept the axiom that the author of the latter must have been one who "first had it in himself to give"? That is, we must accept the theory of a God who is half good, half evil; or adopt the Zoroastrian conception of a universe contested by an Ormuzd and Ahriman, a good and evil principle, whose power is, for the present at any rate, equally balanced.

From this dilemma there is no escape, unless we give up altogether the idea of an anthropomorphic deity, and adopt frankly the scientific idea of a First Cause, inscrutable and past finding out; and of a universe whose laws we can trace, but of whose real essence we know nothing, and can only suspect or faintly discern a fundamental law which may make the polarity of good and evil a necessary condition of existence. This is a more sublime as well as more rational belief than the old orthodox conception; but there is no doubt that it requires more strength of mind to embrace it, and that it appears cold and cheerless to those who have been accustomed to see special providences in every ordinary occurrence, and to fancy themselves the special objects of supernatural supervision in all the details of daily life. Hopes and fancies, however, are powerless against facts; and the world is as surely passing from the phase of orthodox into that of scientific belief as youth is passing into manhood, and the planet which we inhabit from the fluid and fiery state into that of temperate heat, progressive cooling, and final extinction as the abode of life. In the mean time, what can we do but possess our souls in patience, follow truth wherever it leads us, and trust, as Tennyson advises, that in the long run everything will be for the best, and "every winter turn to spring"?

TWENTY YEARS OF NEGRO EDUCATION.

By J. M. KEATING.

THE negro is no longer a problem. He is part of the body politic and the body social of the republic. He is firmly rooted and can not be moved. He is here to stay; and any attempt to disturb him, or to excite his fears as to his right to life, liberty, and the pursuit of happiness, is nothing less than a crime.

A question touching the negro, like any other, must be considered from this common-sense stand-point, and every suggestion for its solution must be subjected to the probing and searching "What good?"

Prejudice must not be allowed a voice in its solution, and passion must be excluded from counsel. The negro will not consent to his own deportation. The Southern planters, too, would not, if they could, consent to it, nor to any agitation of it, because it unsettles and unhinges the labor that is more profitable free than it ever was or could be in the days of slavery. The negro is more intelligent now than then, and therefore more valuable because a better, a closer, and more skillful worker. Deportation is not, for these reasons, to be considered. We must, therefore, deal with the negro and treat of him with the full understanding that we can not get rid of him. His commercial value, supplementing his rights under the Federal and State Constitutions, says we can not.

What, then, is to be done with the negro? Nothing but increase the number of schools and schoolmasters, make education compulsory, and make technical education easily available to him in all parts of the South. The negro must be taught the virtue of self-reliance, and the value of the courts as his safeguard and defense under the Constitution and laws of the nation and of the States. Agitation exalts the negro to a degree of imaginary importance that people at the North can not understand. He is a sensible man within his limits of mind and comprehension, so long as he feels that he is not the center of a pet anxiety. Agitation has retarded and interfered with his growth in the past; it has proved exceedingly mischievous, and is not to be thought of in the future. It breeds dissatisfaction, raises hopes that can never be fulfilled, and tends to widen the breach between the races. For these reasons Mr. Cable's suggestion of opening the schools of the South in common to blacks and whites is not to be entertained.* The race-feeling and race-prejudice that everywhere, wherever the Anglo-Saxons come in contact with the negro, keep them apart, will not brook it, nor will it permit the acceptance of the opening of concert halls, theatres, or lecture halls indiscriminately to both races. The same may be said of hotels and steamboats. It will not do to arouse prejudices—we must allay them. But even if the race-instinct theory be wrong, and it is found that there is nothing more serious than a prejudice that may disappear before the sun of truth, of justice, and of right, it is not policy to arouse it by fixed or a purposed antagonism. It will disappear in time; it will be swept away by the uplifting of the negro to a plane whence he can prove his title to as high consideration in all respects as his white brother. The education of the negro has uplifted and will uplift him, and will prove the solid and enduring cause for the effect desired, if anything can. A soft an-

* The evil effect of an attempt at mixed schools was felt in Louisiana; the superintendent of which State, in 1871, complained that the act forbidding the establishment of public schools from which colored children should be rejected excited determined opposition on the part of many who would otherwise co-operate in the opening of schools, and in the raising of funds for their support.

swer turneth away wrath. What is most needed, then, is not an aggressive agitation for social recognition in public places and conveyances, and in schools and churches, but education. Educate the negro, that he may be really free. The whole power of public opinion should be brought to the enlargement of the means of educating the negro, giving him a practical training that will fit him for daily practical life, and enable him to compete successfully with his white brother in useful vocations. Elevation of character comes with education, pride with elevation of character, and uprightness, integrity, thrift, and decency are the sure products of pride. The homes of the educated and skilled labor of our country tell the whole story of the difference between that and unskilled and ignorant labor. Let us look at what has been accomplished by education. Let us review the past, year by year, as we find the figures and facts in Commissioner Eaton's reports, and see what has been done—see if we are justified in thus insisting that education is the sure hope of the negro; and while we look, let us keep constantly in view all the difficulties through which so much has been accomplished—the civil war; the period of political reconstruction, during which all passions and prejudices were allowed the freest play; the utter dejection and poverty of the white people; the extraordinary social upheaval, unequaled in any period of the world's history save during the French Revolution; the mastery of the negro in the political misrule of the Southern States, and the fears of utter ruin beyond recovery by the white people as a result of that mastery in misrule. Let us keep all this steadily in view, and the work of breaking so great a block of black ignorance will seem like a miracle indeed.

In 1860 there were 244,492 adult free colored people in the whole Union, and of that number 95,265 were illiterate, a fact to be accounted for by the laws in force in the Southern States against the education of the negro. In the same year there were out of 4,000,000 of slaves 1,734,000 adults, all of them of course illiterates. The average increase of this 4,000,000 is given by the census of 1860 as 80,000 per year, so that in 1867, when colored school reports became accessible, the total colored population would be, for the eight years including 1860, 4,640,000. Of this number in 1867, according to the Freedman's Bureau statistics, 111,442 were enrolled in the day and night schools throughout the South, and in 1869 this number had increased to 114,522. Very slow progress, in part due to the indifference and opposition of the whites, who about that time were the victims of the reconstruction system, and in greater part to the reckless indifference of a majority of the negroes, who had been plunged in the excesses of political Saturnalias, and were helping the carpet-baggers to rob the States and burden posterity with bonded debts. Chaos and confusion, disappointment and despair prevailed in all the Southern States, and all classes were unsettled. It was no wonder, then, that with this attendance of 114,522 and an additional number of from 30,000 to 35,000 not regularly reported, together with 100,000 more attending Sunday-schools, the gain on the whole body of colored illiteracy was but a fraction of the annual gain of the negro population, not more than 20,000 successfully accomplishing the task of learning to read. But in eleven years all this had changed. The white people of the Southern States had resumed the control of their governments, had brought order out of chaos, diminished the burden of illegally made debt, and reduced taxation, and had thus given relief to all classes, and had established a public-school system for black as well as white children, which has ever since been steadily growing in public favor and increasing in efficiency and power. The result of this may be seen at a glance by the contrast of the statistics of 1869 with those of 1883. In the former year there was a total of 249,522 colored pupils enrolled at the South of all ages and grades, in day and night and Sunday schools; in the latter year there were 16,086 colored schools, colleges, and universities, etc., with an enrollment of 821,380 pupils, the average percentage of illiteracy being about seventy, except in Missouri, Maryland, Delaware, and West Virginia, where it was about fifty-six, a fact largely if not altogether due to the geographical situation of those States, and to their advantages as border States during the war, and to their freedom from the turmoil, dissensions, and difficulties of reconstruction. Nothing can be more instructive as to the position the negro is taking as a citizen and to his appreciation of his responsibilities. In twenty years of freedom he had blotted out thirty per cent of the illiteracy that was the heirloom of the slave, and he had done that under conditions for some years of a menacingly adverse and repressive character. The white people opposed his education because the expense of maintaining public schools would fall upon them, and most of them had a conviction that ever so little education would unsettle the brain of the freedman and elevate him "above his business" as field-hand, house-servant, or mechanic. They were justly incensed, too, at the hostile attitude of the negro and the readiness and eagerness in some instances with which he allied himself with the carpet-baggers and helped that class to postpone the restoration of peace, order, and law.

In 1870 Memphis, Nashville, and New Orleans furnished free schools for the education of negroes, but elsewhere throughout the South there was manifest indisposition and indifference to supporting them. In that year, signalized above all others by the establishment of the Bureau of Education at Washington, and the first of those instructive and exhaustive reports by Commissioner Eaton, which have been continued every year since, and from which all the data of this article are taken, the scholastic colored population between the ages of five and eighteen was, in the whole country, 814,576 boys and 806,402 girls, and the attendance was 88,594 boys and 91,778 girls, but little less than eleven per cent of the whole number, and only 70,000 more than was reported by the Freedman's Bureau in 1867, and 66,000 more than the number it reported the previous year, 1869. Prejudice was very stubborn, and the ignorance of 250 years of imbruting servitude was still an impervious crust. The brave men and women who opposed to this dreadful array the light of their love of humanity, the strength of a keen and alert intelligence, and their hope, looked about them, many of them with breaking hearts. No missionaries to China or Africa ever suffered as did these pioneers in the cause now fostered, encouraged, and supported by the States that at first rejected them. They were looked upon as part of the machinery by which negro rule was to be perpetuated, and they were shunned as intelligent aiders and abettors of mischief and ruin. Besides this, the Freedman's Bureau was regarded as obnoxious in its workings and its tendencies. Under these circumstances it was to be expected that very discouraging reports would be made, and we are not surprised, therefore, to learn that Delaware had in 1870 made no provision for the education of negro children; that in Maryland the negro children were utterly ignored, save in Baltimore; Kentucky practically ignored the colored children; West Virginia seemed to be contemplating the destruction of its common-school system; Virginia was struggling through ignorance of what free schools should be to the establishment of a system; North Carolina was still in a hopeless condition; and Tennessee, save in Memphis and Nashville, and the counties of Davidson, Greene, and Montgomery, had no schools for whites or blacks. This is a very black picture, but it was not without its relief. Missouri had a free-school system firmly established; Arkansas, encountering the obstacles common to the regions where slavery had been abolished, had secured a greater success than a majority of the Southern States; South Carolina, with the largest percentage of illiteracy, was confident of final success; Florida, in spite of some drawbacks, presented more reasons for anticipating the general prevalence of free schools; but Alabama, after giving the most flattering promises, was debating the question of advancing or retreating; Mississippi, although commencing late, was progressing steadily and efficiently in the establishment of a system of free schools, notwithstanding the great and bitter opposition, appointing county superintendents, collecting the school-tax, and building school-houses; Louisiana's report was most unsatisfactory; Georgia had just passed a school law, but must wait a year for funds before commencing operations; in Texas things looked hopeless, there was no school legislation, and the entire population was left to grow up in ignorance, save as private enterprise threw a ray of light upon the general darkness. The District of Columbia alone made an exhibit that was encouraging, and that was relatively as good as that made by the white children. In public and private schools there were 4,613 colored children out of a total school population of 10,494. This was the one ray of positive light in all that darkness. Elsewhere and farther South there were only glimmers to encourage the mere "handful of men and women" who were laboring for the advancement of the negro. Governor "Joe" Brown, of Georgia, furnished one of these. As a result of the examination of the pupils of Atlanta University, he reported that "many of the pupils exhibited a degree of mental culture which, considering the length of time their minds have been in training, would do credit to members of any race." This was valuable and timely testimony from a high and reliable quarter. In the same year Dr. J. L. M. Curry, now of the Peabody Fund, in a speech in Brooklyn, admitting the defects in the public-school system at the South, declared that the people were awakening to the necessity of education, and "the colored people as citizens and wards of the nation need to be qualified for their exalted responsibilities. Especially do they need trained and educated teachers of their own race. If practicable, a degraded race should be elevated and delivered by their own class, as the patronage of the superior has a tendency to degrade character." This was as the voice of the awakened South, rising out of the ashes of despair and once more asserting her place in the Union and her responsibilities in helping to advance the work of American civilization. It found an echo here and there. A planter, witnessing the school examination at Athens, Alabama, in that year, said he had "no prejudices against the education of the colored race," and hoped "the children would improve their time." These were the breaks in the dense mass of opposition to the education of the negro. Few as they were, these echoes were encouraging to the noble and ever-to-be-revered band of men and women engaged in the work, the servants of Northern institutions or churches whose voluntary contributions to sustain the work had by the beginning of 1871 reached, with the expenditures of the Freedman's Bureau, the grand total of $7,317,311. Of this sum, expended in from six to eight years, the American Missionary Association paid out $1,663,756; the Freedman's Bureau, $3,711,235; and in other things than cash, $1,551,276, making a total of $5,262,511; the Presbyterian Church (North), $220,701; the Freedman's Aid Society, $134,340; and the Baptists of the District of Columbia, $36,000. A noble return, surely, for the scorn, contumely, hate, and malevolent opposition with which the teachers of negro schools were met by communities stung to the quick by the outrages put upon them by disfranchisement and political subordination to an ignorant race, the ready tools of designing knaves.

In 1871 but little improvement had been made. The general public was still indifferent, and there was much opposition to colored schools. A convention of Southern Baptists at Marion, Alabama, denounced the common-school system as fostering infidelity, and declared that the "only hope was in Christian education in our own schools." In Louisiana persons were deterred from accepting the position of school directors, dreading social ostracism and persecution. In the third district the teachers submitted to social and personal discomfort, ostracism, and opprobrium, and were compelled to wait for months for their pay. Yet progress was made. At one of the institutes a division superintendent stated that last year (1870) he could report but seventy-one schools, 97 teachers, and 3,600 pupils in fourteen parishes, whereas now he reported one hundred and thirty-three schools, 150 teachers, and 7,500 pupils, and the number constantly increasing. The difficulties as stated by the State Superintendent were "indifference and incompetency of the teachers; extreme poverty of the people, and the embarrassed condition of the State's finances; yet, notwithstanding this, they were laying the foundation of a thorough, practical, and liberal system of common schools." In Georgia there was great activity in wise ways to promote the free education of the whites, but the "colored people have hardly been permitted to do what they would for themselves freely." They had but ninety-seven public schools and only 5,208 pupils. Florida had little or no progress to note, but there were negro schools in nearly every county. Kentucky apparently refused to recognize "the desirableness or necessity of the education of the colored children." In Tennessee there was much agitation, but it was not attended with success, and the colored people were emphatic in the statement of the difficulties encountered by them in their efforts to educate their children. In Alabama the opposition to the free schools was discouraging, and while the colored people had the advantage of the Swayne School at Montgomery and the Emerson Institute at Mobile, they complained in many of the counties of great difficulty, or of the impossibility of "securing any school privileges." In Mississippi the enforcement of the free school law, especially as to negro schools, was opposed, even to "the whipping of teachers and burning of school-houses." Yet there were not less than three thousand schools in operation, and the system was gaining friends. Texas was the darkest field educationally in the United States, though the Governor, supported by a strong array of friends, was supporting and doing all he could for public instruction. Arkansas, though in some respects leading all the other ex-slave States, was yet far from the line of approximate perfection. The public schools were open to negroes, but only one fourth of the number of scholars were enrolled. In Missouri the public schools had passed beyond a period of peril, and only one county was especially opposed to negro education. In Delaware no provision had yet been made for the education of the negro. Of Maryland the same report was made. Virginia and West Virginia had both made progress. North Carolina had lost ground educationally, and the severe proscription of colored people had greatly discouraged their efforts for themselves. Of the schools in South Carolina very little favorable could be said. The friends of education struggled against overwhelming odds. In the District of Columbia there were sixty-nine colored schools; 4,986 children enrolled out of 9,323; average attendance, 2,990. More than sixty per cent failed to attend, a proof of the indifference of the negro to education at that time, a greater barrier to progress than the opposition of the whites.

In 1872 the reaction had fairly set in. There was much in the reports to encourage the friends of negro education. Delaware and Kentucky were the only States that had not made provision for the instruction of colored children.

In 1873 the improvement was most marked. Kentucky reported an educational revival, and steps had been taken toward a general education of the colored children. Delaware had not yet made any provision for the education of this class, and that work was still carried on by an association supported by the voluntary subscriptions of philanthropic people. Missouri had one school for training colored teachers.

In 1874 improvement could be observed in almost all the Southern States. Maryland increased her schools by 60, her teachers by 134, and her expenditures by $108,824.70. Virginia increased her expenditures by $58,651.21, her schools by 205, school-buildings by 263, and the number of pupils by 13,016. Two schools for training colored teachers had 300 pupils. In North Carolina, 50,000 colored pupils attended the public schools. South Carolina reported an increase of 162 teachers, 196 schools, 192 new school-houses, and 56,249 colored pupils enrolled. Georgia reported 669 schools for colored children, with an enrollment of 37,267. Florida reported an increase in the number of schools 46, and of pupils 1,586. Louisiana reported a gain in the receipts for schools of $110,595.43, in attendance of 16,866 pupils, in the number of schools 175, and of teachers 18. Delaware, Texas, Arkansas, and Alabama were at a stand-still. In Mississippi the free schools were receiving very general support, and one third of the whole number of children of school age were in attendance upon the public schools, on which $900,000 had been expended, the value of school property being $505,790.56. Tennessee reported more than half her school population enrolled, and more than one third in attendance. Missouri showed some elements of progress, such as an increase of 2,537 in school population, $72,198.41 in receipts, and $714,548.83 in permanent school funds. The normal schools—State, collegiate, city, and independent—had 1,887 pupils. In Kentucky public sentiment was more in favor of public schools, and one hundred and forty-one new school-houses were built. West Virginia reported an increase of school-buildings 218, and of attendance 27,256. Besides the general improvement in public schools, all the private schools were flourishing, and the same was to be said of the colleges and universities, the normal schools for both sexes and both colors reporting a greatly increased attendance, the result of a rapidly increasing demand for teachers. The American Missionary Association was rivaling the public efforts in furnishing educational facilities for the colored people, especially in preparing pupils for the field that was now widening every day as a result of its early missionary efforts. The Peabody fund was also being distributed in a discriminating and effective way, and the friends of education were greatly encouraged. The tide had turned. Public sentiment had at last come up almost unto the strength of unanimity for public education, and it was being generally conceded that the most pressing duty was the breaking up of the great mass of illiteracy, and that the negro must be educated to be fitted for the duties of citizenship.

The outlook in 1875 was still more encouraging, Delaware had organized a thorough school system under a new law, the colored children being provided for by a special tax levied on the colored population. West Virginia reported five normal schools, having 557 students and 85 graduates; North Carolina, 600 teachers in training in teachers' institutes and normal schools "for a demand that could not be supplied"; South Carolina, 39 pupils in the State Normal School; Alabama, three State Normal Schools and five similiar institutions supported by societies, all having 659 students, of whom 533 were believed to be colored; Mississippi, two State Normal Schools for colored pupils, with 351 students. Arkansas had taken a fresh start under the provisions of its newly adopted constitution. In the State Industrial University 58 white students were being trained as teachers, and in another institution sustained by a society, 156 were in training for colored schools. In Tennessee, a normal school had been established. Kentucky for the first time included the colored children in the enrollment of school-children. There was no State Normal School as yet, but 140 normal pupils were reported in two institutions, and 29 graduates from the Louisville Normal School. Missouri returned three State Normal Schools, with 644 pupils.

The year 1876 was a presidential year, and was not favorable, on the whole, to the interests of education. Nevertheless, Commissioner Eaton, in summing up the results of all the reports from the South, was able to say that "after a careful review of these facts, and an attentive consideration of them in their several relations, and with full recognition of the same backward tendency in certain other localities, I am increasingly convinced that their local public sentiment will not tolerate any further retrogression in these States; and that the friends of education may, on the whole, anticipate for their efforts increasing public favor."

In 1877 the reports from the South were gratifying and encouraging. The reconstruction period was ended, and we found ourselves getting on rising ground. The total number of negro children of school age in the late slave States was 1,513,065, and those enrolled, 571,506. There were for these 10,792 schools; besides which there were twenty-seven normal schools, with 3,785 pupils; twenty-three institutions for secondary instruction, with 2,807 pupils; thirteen universities and colleges, with 1,270 pupils; seventeen schools of theology, with 462 pupils; two schools of law, with 14 pupils; three schools of medicine, with 74 pupils; and two schools for the deaf and dumb and the blind, with 99 pupils; making a grand total of 10,879 schools, colleges, etc., and 580,017 pupils enrolled.

The reports for 1878, notwithstanding the yellow-fever epidemic that prevailed throughout the whole of the lower valley of the Mississippi, were extremely encouraging. All the States did well.

The years 1879, 1880, and 1881 were years of general progress. The former year witnessed the fair inauguration of normal instruction in Texas for both white and colored. In Kentucky nine private normal schools and institutes held in fourteen counties, and a summer normal school, were doing good work for teachers. The report for 1880 was, taking in the whole field, more encouraging than any of the preceding ones. The Agricultural and Mechanical College of Missisipi was opened with two hundred students. In 1881, Delaware for the first time recognized its obligations to the colored children and appropriated $2,400 from the State Treasury for these schools. West Virginia made provision for the free education of eighteen colored pupils at Storer College. In 1882–'83 the white-school population of the sixteen once slave States and the District of Columbia was 4,046,956, and the enrollment in public schools 2,249,263. The colored-school population was 1,944,572; enrollment, 802,982. Compared with the figures of 1877 there was clear evidence of the remarkable work that had been accomplished in the Southern States. The white-school population showed an increase of 13 per cent; enrollment, 23 per cent; the colored-school population showed an increase of 28 per cent; enrollment increase, 40 per cent. The expenditures during that time had steadily increased as follows: In 1878 they were $11,760,251; in 1879, $12,181,602; in 1880, $12,475,044; in 1881, $13,359,784; and in 1882, $14,820,972. And this, notwithstanding there had been a decrease in the value of the taxable wealth of ten of the Southern States amounting to $411,475,000. Notwithstanding which, these States now appropriated 20·1 per cent of their total levy of taxes for school purposes, New England at the same time paying 20·2; the Middle States, 19·5; the Western States, 26·2; and the Territories, 22·4; the average of the whole country being 22·6 per cent. This increase in funds corresponded with a radical change in public sentiment. Louisiana was the only State in which the prospect was in the main discouraging. Both races shared alike in the school fund in all the States except in Delaware, Maryland, and the District of Columbia, in which special provision was made for the colored race, and in South Carolina, where the basis of apportionment was the same for each race, but the amounts realized depended upon the extent to which the people availed themselves of the provision by attendance upon the schools.

The total number of colored children of school age in the late slave States was in 1882, 1,944,572, an increase of 15,385; and of those enrolled, 802,982, an increase of 610. There were for these 15,972 schools a decrease of 1,681. Besides which there were fifty-six normal schools, an increase of nine, with 8,509 pupils, an increase of 888; forty-three institutions for secondary instruction, an increase of nine, with 6,632 pupils, an increase of 1,348; eighteen universities and colleges, an increase of one, with 2,298 pupils, an increase of 95; twenty-four schools of theology, an increase of two, with 665 pupils, an increase of 61; four schools of law, an increase of one, with 53 pupils, an increase of 8; three schools of medicine, an increase of one, with 125 pupils, an increase of 9; six schools for the deaf and dumb and the blind, an increase of four, with 116 pupils, a decrease of 4; making a grand total of 16,086 schools, colleges, etc., a decrease of 1,289, with 821,380 pupils, an increase of 3,015 over those reported in 1881.

Nothing in the progress of the South since the close of the civil war is so gratifying as these exhibits of growth in educational facilities and this steady increase in the number of scholars of both races. The people of the Northern States will never be able to understand or comprehend all that it is to us of the South. All the expenses and money losses of these States during the war were represented in bonds and other forms of Government indebtedness, which were so much of addition to the property values of that section. But the Southern States lost everything—their slaves, their crops, and all the profits of their industrial efforts for five years, their public (Confederate) debt, nearly all of their railroad and steamboat property, fifty per cent of their homesteads, their farm-fences, mills, and gins, the whole representing a total value variously estimated at from $9,000,000,000 to $11,000,000,000. It was a clean sweep—so clean that both Generals Grant and Sherman found it necessary to permit the officers and privates of the Confederate armies to retain their horses and mules to make crops; and Governor Brownlow's Legislature in Tennessee passed an act making the stealing of a mule or a horse punishable by death, on the expressed ground that the mule and the horse were essential to the life of the people—without them bread could not be made. Following upon the heels of this utter destitution and the consequent prostration and despondency, came the period of reconstruction, which increased the confusion that prevailed, re-excited the passions of the war, and added to it all a race-feeling that for a time was at a white heat—a feeling that was a new experience to the people of the South. Out of this extreme of general poverty, out of this race-feeling and political passion and prejudice, order was slowly evoked, and with it came the steady growth of a healthy public sentiment favorable first to public education and then to the education of the negro.

As fast as they have been able, the Southern States have increased their taxes for school purposes and their facilities for the education of teachers until they have reached a point as high as that of New England—that is, they appropriate twenty per cent of the whole amount of taxes levied and collected for school purposes, just as Massachusetts does. Beyond this they can not go any faster than their growth in taxable wealth will permit, and unless they have an even greater amount of help than has been given by the American Missionary Association, the Sears and the Peabody Funds, educational progress must be very slow—too slow to meet the demands of the people. It would take three times the amount now annually appropriated by the Southern States ($15,000,000) to satisfy the demands of the six million black and white children for education. With anything like an adequate sum, and compulsory laws to overcome the lethargy and indifference of the negroes, an inroad so broad might be made in a few years in the illiteracy that is now a positive menace and danger to these States as to encourage the friends of education in the belief of a possible millennium, when every human being would be able to stand an examination in at least the three R's. And this, however chimerical it may seem, contrasted with existing facts, is what must be kept steadily in view. The State owes it to every child to make it intellectually strong enough to understand the necessity for law, to submit to the restraints of law, and obey law. This can only be done by education.

Looking back through the years the educational work of which has thus been traced in the foregoing pages, we find that several good results have been accomplished: 1. The prejudices of the Southern people against the education of the negro have been utterly and entirely dispelled; 2. The people of the South have become willing, in most cases enthusiastic supporters and helpers in the education of the negro; 3. Thirty per cent of the illiteracy of the negro has been wiped out; and, 4. The negro has steadily, though gradually, been brought to realize that in education he is to find perfect freedom, the soul and heart freedom of which no man may rob him; that by education he is to be elevated, lifted up above the chaos and confusion of ignorance, and prepared for whatever of destiny lies before him in the United States. With these results before us, to raise any side or outside issues that would tend to re-excite the prejudices of the whites against the blacks, to raise the social question, even in the least degree, is to be at enmity with the peace and prosperity of the negro, to hurt and injure the cause of his education, to retard his growth mentally and morally, and postpone the time when he might claim equality in both senses.

In the face of such progress, to advocate the deportation of such a race, or any scheme of separate colonization, is nothing less than a crime. It has the effect to disturb and check the flow of this steady tendency toward the average of civilization reached by the white race; it has the tendency to excite fear and to paralyze the race that still looks to the white man to continue to guarantee to it its political rights, and for the recognition of the full equality before the law that assures him the peaceful pursuit of happiness and the possession of property. By education a great gap has been made in the mountain of illiteracy that was first assailed in 1862 with many forebodings and much doubt. The philanthropic men and women who first undertook the task have many of them passed to their reward; but their works do follow them. The better outlook that enabled them to see away beyond the stormy years to come and predict this better day has been fully justified, and none more eagerly bear testimony, and willing testimony, to the beneficence and blessings of that work than the white men and women who were born again to their better natures out of and away beyond the prejudices of centuries, and to-day rejoice in the living light that shines from books on the negro's intellect and heart, enabling him to grasp hitherto hidden meanings and comprehend some of the treasures of our literature and make himself strong for the battle of life. The man who survives by his own strength and will excites admiration; the man who has to be helped becomes a burden, and a wearisome burden, to all about him. Educate, educate the negro. Make the ways of light broader; make the avenues to better life and living plainer. Illuminate him with the intelligence of the ages and the light of reason, and the negro will see his own way and walk without help. He will become a stronger, a more self-reliant man, and by that strength and self-reliance will beat down all the barriers and shake off all the make-weights that impede his progress and stand in his way. He will be a citizen, indeed, and not a halting, wailing child. He will be a man full of man's ways and purposes, with a comprehensive grasp of his duties and a sound, sensibly guided determination to be in every case a citizen equal to the maintenance of his own rights under the law, a strength and not a weakness to the republic. Education, and not agitation, is what the negro needs. He needs repose and rest, time to think of himself and for himself, to realize what he has accomplished in a few years, how closely he stands to his white neighbors, and how intimately his destiny is linked with theirs. Hitherto he has been constantly in a very sea of turmoil, tossed about, anxious, and confused. Under these circumstances, his own natural disinclination, the poverty of the Southern States, and the political bedevilments that made at the South confusion worse confounded until 1876, the advance he has made in education and in the acquisition of property is like the work of magic. In peace, in freedom from political agitation, with increased facilities for education, sustained by the good-will and the voluntary taxation of the white people, what may he not be expected to accomplish in the future? When seventy per cent of his illiteracy has been swept away, what a self-respecting man he will have become! But when ninety per cent has gone, he will be able to hold his head as high as the best; and the accomplishment of this percentage is not half so difficult now as the task encountered by the pioneers who first blazed a path in the wilderness of ignorance and superstition in which they found him in 1862. Educate the negro, and he becomes free indeed in "mind, body, and estate."

RELATIONS OF SCIENCE TO THE PUBLIC WEAL.*

BY SIR LYON PLAYFAIR, K. C. B., M. P., F. R. S.

PART FIRST.

I. VISIT TO CANADA.—LADIES AND GENTLEMEN: Our last meeting at Montreal was a notable event in the life of the British Association, and even marked a distinct epoch in the history of civilization. It was by no mere accident that the constitution of the Association enabled it to embrace all parts of the British Empire. Science is truly catholic, and is bounded only by the universe. In relation to our vast empire, science as well as literature and art are the common possession of all its varying people. The United Kingdom is limited to 120,800 square miles, inhabited by thirty-five million people; but the empire as a whole has eight and one half million square miles, with a population of three hundred and five millions. To federate such vast possessions and so teeming a population into a political unit is a work only to be accomplished by the labors and persistent efforts of perhaps several generations of statesmen. The federation of its science is a subject of less dimensions well within the range of experiment. No part of the British Empire was more suited than Canada to try whether her science could be federated with our science. Canada has lately federated distinct provinces, with conflicting interests arising from difference of races, nationalities, and religions. Political federation is not new in the history of the world, though it generally arises as a consequence of war. It was war that taught the Netherlands to federate in 1619. It was war which united the States in America; federated Switzerland, Germany, and Austria, and unified Italy. But Canada formed a great national life out of petty provincial existences in a time of profound peace. This evolution gave an immense impulse to her national resources. The Dominion still requires consolidation in its vast extent, and applied science is rapidly effecting it. Canada, with its great expanse of territory, nearly as large as the United States, is being knit together by the iron bands of

* Inaugural address of the President of the British Association for the Advancement of Science, at the Aberdeen meeting, September 9, 1885.

railways from the Gulf of St. Lawrence to the Pacific Ocean, so that the fertile lands of Ontario, Manitoba, Columbia, and the Northwestern Territories will soon be available to the world. Still, practical science has much to accomplish. England and France, with only one fifth the fertile area of Canada, support eighty million people, while Canada has a population not exceeding five million.

A less far-seeing people than the Canadians might have invited the applied science which they so much require. But they knew that without science there are no applications. They no doubt felt with Emerson—

> "And what if Trade sow cities
> Like shells along the shore,
> And thatch with towns the prairie broad
> With railways ironed o'er;
> They are but sailing foam-bells
> Along Thought's causing stream,
> And take their shape and sun-color
> From him that sends the dream."

So it was with a far-reaching foresight that the Canadian Government invited the British Association for the Advancement of Science to meet in Montreal. The inhabitants of Canada received us with open arms, and the science of the Dominion and that of the United Kingdom were welded. We found in Canada, as we had every reason to expect, men of manly and self-reliant character, who loved not less than we did the old home from which they had come. Among them is the same healthiness of political and moral life, with the same love of truth which distinguishes the English people. Our great men are their great men; our Shakespeare, Milton, and Burns belong to them as much as to ourselves; our Newton, Dalton, Faraday, and Darwin are their men of science as much as they are ours. Thus a common possession and mutual sympathy made the meeting in Canada a successful effort to stimulate the progress of science, while it established, at the same time, the principle that all people of British origin—and I would fain include our cousins in the United States—possess a common interest in the intellectual glories of their race, and ought, in science at least, to constitute part and parcel of a common empire, whose heart may beat in the small islands of the Northern seas, but whose blood circulates in all her limbs, carrying warmth to them, and bringing back vigor to us. Nothing can be more cheering to our association than to know that many of the young communities of English-speaking people all over the globe—in India, China, Japan, the Straits, Ceylon, Australia, New Zealand, the Cape—have founded scientific societies in order to promote the growth of scientific research. No doubt science, which is only a form of truth, is one in all lands, but still its unity of purpose and fulfillment received an important practical expression by our visit to Canada. This community of science will be continued by the fact that we have invited Sir William Dawson, of Montreal, to be our next president at Birmingham.

II. Science and the State.—I can not address you in Aberdeen without recollecting that when we last met in this city our president was a great prince. The just verdict of time is that, high as was his royal rank, he has a far nobler claim to our regard as a lover of humanity in its widest sense, and especially as a lover of those arts and sciences which do so much to adorn it. On September 14, 1859, I sat on this platform and listened to the eloquent address and wise counsel of the Prince Consort. At one time a member of his household, it was my privilege to co-operate with this illustrious prince in many questions relating to the advancement of science. I naturally, therefore, turn to his presidential address to see whether I might not now continue those counsels which he then gave with all the breadth and comprehensiveness of his masterly speeches. I found, as I expected, a text for my own discourse in some pregnant remarks which he made upon the relation of science to the state. They are as follows: "We may be justified in hoping . . . that the Legislature and the state will more and more recognize the claims of science to their attention; so that it may no longer require the begging-box, but speak to the state like a favored child to its parent, sure of his paternal solicitude for its welfare; that the state will recognize in science one of its elements of strength and prosperity, to foster which the clearest dictates of self-interest demand."

This opinion, in its broadest sense, means that the relations of science to the state should be made more intimate because the advance of science is needful to the public weal.

The importance of promoting science as a duty of statecraft was well enough known to the ancients, especially to the Greeks and Arabs, but it ceased to be recognized in the dark ages, and was lost to sight during the revival of letters in the fifteenth and sixteenth centuries. Germany and France, which are now in such active competition in promoting science, have only publicly acknowledged its national importance in recent times. Even in the last century, though France had its Lavoisier and Germany its Leibnitz, their Governments did not know the value of science. When the former was condemned to death in the Reign of Terror, a petition was presented to the rulers that his life might be spared for a few weeks, in order that he might complete some important experiments, but the reply was, "The republic has no need of *savants*." Earlier in the century the much-praised Frederick William of Prussia shouted with a loud voice, during a graduation ceremony in the University of Frankfort, "An ounce of mother-wit is worth a ton of university wisdom!" Both France and Germany are now ashamed of these utterances of their rulers, and make energetic efforts to advance science with the aid of their national resources. More remarkable is it to see a young nation like the United States reserving 150,000,000 acres of national lands for the promotion of scientific education. In some respects this young country is in advance of all European nations in joining science to its administrative offices. Its scientific publications, like the great paleontological work embodying the researches of Professor Marsh and his associates in the Geological Survey, are an example to other Governments. The Minister of Agriculture is surrounded with a staff of botanists and chemists. The Home Secretary is aided by a special Scientific Commission to investigate the habits, migrations, and food of fishes, and the latter has at its disposal two specially constructed steamers of large tonnage. The United States and Great Britain promote fisheries on distinct systems. In this country we are perpetually issuing expensive commissions to visit the coasts, in order to ascertain the experiences of fishermen. I have acted as chairman of one of these Royal Commissions, and found that the fishermen, having only a knowledge of a small area, gave the most contradictory and unsatisfactory evidence. In America the questions are put to Nature, and not to fishermen. Exact and searching investigations are made into the life-history of the fishes, into the temperature of the sea in which they live and spawn, into the nature of their food, and into the habits of their natural enemies. For this purpose the Government gave the co-operation of the navy, and provided the Commission with a special corps of skilled naturalists, some of whom go out with the steamships, and others work in the biological laboratories at Wood's Holl, Massachusetts, or at Washington. The different universities send their best naturalists to aid in these investigations, which are under the direction of Mr. Baird, of the Smithsonian Institution. The annual cost of the Federal Commission is about forty thousand pounds, while the separate States spend about twenty thousand pounds in local efforts. The practical results flowing from these scientific investigations have been important. The inland waters and rivers have been stocked with fish of the best and most suitable kinds. Even the great ocean which washes the coasts of the United States is beginning to be affected by the knowledge thus acquired, and a sensible result is already produced upon the most important of its fisheries. The United Kingdom largely depends upon its fisheries, but as yet our Government have scarcely realized the value of such scientific investigations as those pursued with success by the United States. Less systematically, but with great benefit to science, our own Government has used the surveying expeditions, and sometimes has equipped special expeditions to promote natural history and solar physics. Some of the latter, like the voyage of the Challenger, have added largely to the store of knowledge; while the former, though not primarily intended for scientific research, have had an indirect result of infinite value by becoming training-schools for such investigators as Edward Forbes, Darwin, Hooker, Huxley, Wyville Thomson, and others.

In the United Kingdom we are just beginning to understand the wisdom of Washington's farewell address to his countrymen, when he said: "Promote as an object of primary importance institutions for the general diffusion of knowledge. In proportion as the structure of a government gives force to public opinion, it is essential that public opinion should be enlightened." It was only in 1870 that our Parliament established a system of national primary education. Secondary education is chaotic, and remains unconnected with the state, while the higher education of the universities is only brought at distant intervals under the view of the state. All great countries except England have Ministers of Education, but this country has only ministers who are the managers of primary schools. We are inferior even to smaller countries in the absence of organized state supervision of education. Greece, Portugal, Egypt, and Japan have distinct Ministers of Education, and so also among our colonies have Victoria and New Zealand. Gradually England is gathering materials for the establishment of an efficient education minister. The Department of Science and Art is doing excellent work in diffusing a taste for elementary science among the working-classes. There are now about seventy-eight thousand persons who annually come under the influence of its science classes, while a small number of about two hundred, many of them teachers, receive thorough instruction in science at the excellent school in South Kensington, of which Professor Huxley is the dean. I do not dwell on the work of this Government department, because my object is chiefly to point out how it is that science lags in its progress in the United Kingdom owing to the deficient interest taken in it by the middle and upper classes. The working-classes are being roused from their indifference. They show this by their selection of scientific men as candidates at the next election. Among these are Professors Stuart, Roscoe, Maskelyne, and Rücker. It has its significance that such a humble representative of science as myself received invitations from working-class constituencies in more than a dozen of the leading manufacturing towns. In the next Parliament I do not doubt that a Minister of Education will be created as a nucleus round which the various educational materials may crystallize in a definite form.

III. Science and Secondary Education.—Various Royal Commissions have made inquiries and issued recommendations in regard to our public and endowed schools. The commissions of 1861, 1864, 1868, and 1873 have expressed the strongest disapproval of the condition of our schools, and, so far as science is concerned, their state is much the same as when the Duke of Devonshire's commission in 1873 reported in the following words: "Considering the increasing importance of science to the material interests of the country, we can not but regard its almost total exclusion from the training of the upper and middle classes as little less than a national misfortune." No doubt there are exceptional cases and some brilliant examples of improvement since these words were written, but generally throughout the country teaching in science is a name rather than a reality. The Technical Commission which reported last year can only point to three schools in Great Britain in which science is fully and adequately taught. While the commission gives us the consolation that England is still in advance as an industrial nation, it warns us that foreign nations, which were not long ago far behind, are now making more rapid progress than this country, and will soon pass it in the race of competition unless we give increased attention to science in public education. A few of the large towns, notably Manchester, Bradford, Huddersfield, and Birmingham, are doing so. The working-classes are now receiving better instruction in science than the middle classes. The competition of actual life asserts its own conditions, for the children of the latter find increasing difficulty in obtaining employment. The cause of this lies in the fact that the schools for the middle classes have not yet adapted themselves to the needs of modern life. It is true that many of the endowed schools have been put under new schemes, but, as there is no public supervision or inspection of them, we have no knowledge as to whether they have prospered or slipped back. Many corporate schools have arisen, some of them, like Clifton, Cheltenham, and Marlborough Colleges, doing excellent educational work, though as regards all of them the public have no rights, and can not enforce guarantees for efficiency. A return just issued, on the motion of Sir John Lubbock, shows a lamentable deficiency in science-teaching in a great proportion of the endowed schools. While twelve to sixteen hours per week are devoted to classics, two to three hours are considered ample for science in a large proportion of the schools. In Scotland there are only six schools in the return which give more than two hours to science weekly, while in many schools its teaching is wholly omitted. Every other part of the kingdom stands in a better position than Scotland in relation to the science of its endowed schools. The old traditions of education stick as firmly to schools as a limpet does to a rock; though I do the limpet injustice, for it does make excursions to seek pastures new. Are we to give up in despair because an exclusive system of classical education has resisted the assaults of such cultivated authors as Milton, Montaigne, Cowley, and Locke? There was once an enlightened Emperor of China, Chi Hwangti, who knew that his country was kept back by its exclusive devotion to the classics of Confucius and Mencius. He invited five hundred of the teachers to bring their copies of these authors to Peking, and, after giving a great banquet in their honor, he buried alive the professors along with their manuscripts in a deep pit. But Confucius and Mencius still reign supreme. I advocate milder measures, and depend for their adoption on the force of public opinion. The needs of modern life will force schools to adapt themselves to a scientific age. Grammar-schools believe themselves to be immortal. Those curious immortals—the Struldbrugs—described by Swift, ultimately regretted their immortality, because they found themselves out of touch, sympathy, and fitness with the centuries in which they lived.

As there is no use clamoring for an instrument of more compass and power until we have made up our mind as to the tune, Professor Huxley, in his evidence before a Parliamentary Committee in 1884, has given a time-table for grammar-schools. He demands that out of their forty hours for public and private study ten should be given to modern languages and history, eight to arithmetic and mathematics, six to science, and two to geography, thus leaving fourteen hours to the dead languages. No time-table would, however, be suitable to all schools. The great public schools of England will continue to be the gymnasia for the upper classes, and should devote much of their time to classical and literary culture. Even now they introduce into their curriculum subjects unknown to them when the Royal Commission of 1868 reported, though they still accept science with timidity. Unfortunately, the other grammar-schools which educate the middle classes look to the higher public schools as a type to which they should conform, although their functions are so different. It is in the interest of the higher public schools that this difference should be recognized, so that, while they give an all-round education and expand their curriculum by a freer recognition of the value of science as an educational power in developing the faculties of the upper classes, the schools for the middle classes should adapt themselves to the needs of their existence, and not keep up a slavish imitation of schools with a different function. The old classical grammar-schools may view these remarks as a direct attack upon them, and so it is in one sense, but it is like the stroke of Ithuriel's spear, which heals while it wounds.

The stock argument against the introduction of modern subjects into grammar-schools is that it is better to teach Latin and Greek thoroughly rather than various subjects less completely. But is it true that thoroughness in teaching dead languages is the result of an exclusive system? In 1868 the Royal Commission stated that even in the few great public schools thoroughness was only given to thirty per cent of the scholars, at the sacrifice of seventy per cent who got little benefit from the system. Since then the curriculum has been widened and the teaching has improved. I question the soundness of the principle that it is better to limit the attention of the pupils mainly to Latin and Greek, highly as I value their educational power to a certain order of minds. As in biology the bodily development of animals is from the general to the special, so is it in the mental development of man. In the school a boy should be aided to discover the class of knowledge that is best suited for his mental capacities, so that, in the upper forms of the school and in the university, knowledge may be specialized in order to cultivate the powers of the man to their fullest extent. Shakespeare's educational formula may not be altogether true, but it contains a broad basis of truth:

> "No profit goes, where is no pleasure ta'en;
> In brief, sir, study what you most affect."

The comparative failure of the modern side of school education arises from constituting it out of the boys who are looked upon as classical asses. Milton pointed out that in all schools there are boys to whom the dead languages are "like thorns and thistles," which form a poor nourishment even for asses. If teachers looked upon these classical asses as beings who might receive mental nurture according to their nature, much higher results would follow the bifurcation of our schools. Saul went out to look for asses, and he found a kingdom. Surely this fact is more encouraging than the example of Gideon, who "took thorns of the wilderness and briers, and with these he *taught* the men of Succoth." * The adaptation of public schools to a scientific age does not involve a contest as to whether science or classics shall prevail, for both are indispensable to true education. The real question is whether schools will undertake the duty of molding the minds of boys according to their mental varieties. Classics, from their structural perfection and power of awakening dormant faculties, have claims to precedence in education, but they have none to a practical monopoly. It is by claiming the latter that teachers sacrifice mental receptivity to a Procrustean uniformity.

The universities are changing their traditions more rapidly than the schools. The *via antiqua* which leads to them is still broad, though a *via moderna*, with branching avenues, is also open to their honors and emoluments. Physical science, which was once neglected, is now encouraged at the universities. As to the seventy per cent of boys who leave schools for life-work without going through the universities, are there no growing signs of discontent which must force a change? The civil service, the learned professions, as well as the army and navy, are now barred by examinations. Do the boys of our public schools easily leap over the bars, although some of them have lately been lowered so as to suit the schools? So difficult are these bars to scholars that crammers take them in hand before they attempt the leap; and this occurs in spite of the large value attached to the dead languages and the small value placed on modern subjects. Thus, in the Indian Civil-Service examinations, 800 marks as a maximum are assigned to Latin, 600 to Greek, 500 to chemistry, and 300 to each of the other physical sciences. But, if we take the average working of the system for the last four years, we find that, while sixty-eight per cent of the maximum were given to candidates in Greek and Latin, only forty-five per cent were accorded to candidates in chemistry,

* Judges viii, 16.

and but thirty per cent to the other physical sciences. Schools sending up boys for competition naturally shun subjects which are dealt with so hardly and so heavily handicapped by the state.

Passing from learned or public professions to commerce, how is it that in our great commercial centers, foreigners—German, Swiss, Dutch, and even Greeks—push aside our English youth and take the places of profit which belong to them by national inheritance? How is it that in our colonies, like those in South Africa, German enterprise is pushing aside English incapacity? How is it that we find whole branches of manufactures, when they depend on scientific knowledge, passing away from this country, in which they originated, in order to ingraft themselves abroad, although their decaying roots remain at home?* The answer to these questions is that our systems of education are still too narrow for the increasing struggle of life.

Faraday, who had no narrow views in regard to education, deplored the future of our youth in the competition of the world, because, as he said with sadness, "our school-boys, when they come out of school, are ignorant of their ignorance at the end of all that education."

The opponents of science education allege that it is not adapted for mental development, because scientific facts are often disjointed and exercise only the memory. Those who argue thus do not know what science is. No doubt an ignorant or half-informed teacher may present science as an accumulation of unconnected facts. At all times and in all subjects there are teachers without æsthetical or philosophical capacity—men who can only see carbonate of lime in a statue by Phidias or Praxiteles; who can not survey zoölogy on account of its millions of species, or botany because of its 130,000 distinct plants; men who can look at trees without getting a conception of a forest, and can not distinguish a stately edifice from its bricks. To teach in that fashion is like going to the tree of science with its glorious fruit in order to pick up a handful of the dry fallen leaves from the ground. It is, however, true that, as science-teaching has had less lengthened experience than that of literature, its methods of instruction are not so matured. Scientific and literary teaching have different methods; for, while the teacher of literature rests on authority and on books for his guidance, the teacher of science discards authority and depends on facts at first hand, and on the book of Nature for their interpretation. Natural science more and more resolves itself into the teaching of the laboratory. In this way it can be used as a powerful means of quickening observation, and of creating a faculty of induction after the manner of Zadig, the Babylonian described by Voltaire. Thus facts become surrounded by scientific conceptions, and are subordinated to order and law.

* See Dr. Perkins's Address to the Society of Chemical Industry.—"Nature," August 6, 1855, p. 333.

It is not those who desire to unite literature with science who degrade education; the degradation is the consequence of the refusal. A violent reaction—too violent to be wise—has lately taken place against classical education in France, where their own vernacular occupies the position of dead languages, while Latin and science are given the same time in the curriculum. In England manufacturers cry out for technical education, in which classical culture shall be excluded. In the schools of the middle classes science rather than technics is needed, because, when the seeds of science are sown, technics as its fruit will appear at the appointed time. Epictetus was wise when he told us to observe that, though sheep eat grass, it is not grass but wool that grows on their backs. Should, however, our grammar-schools persist in their refusal to adapt themselves to the needs of a scientific age, England must follow the example of other European nations and found new modern schools in competition with them. For, as Huxley has put it, we can not continue in this age "of full modern artillery to turn out our boys to do battle in it, equipped only with the sword and shield of an ancient gladiator." In a scientific and keenly competitive age, an exclusive education in the dead languages is a perplexing anomaly. The flowers of literature should be cultivated and gathered, though it is not wise to send men into our fields of industry to gather the harvest when they have been taught only to cull the poppies and to push aside the wheat.

IV. Science and the Universities.—The state has always felt bound to alter and improve universities, even when their endowments are so large as to render it unnecessary to support them by public funds. When universities are poor, Parliament gives aid to them from imperial taxation. In this country that aid has been given with a very sparing hand. Thus the universities and colleges of Ireland have received about £30,000 annually, and the same sum has been granted to the four universities of Scotland. Compared with imperial aid to foreign universities such sums are small. A single German university like Strasburg or Leipsic receives above £40,000 annually, or £10,000 more than the whole colleges of Ireland or of Scotland. Strasburg, for instance, has had her university and its library rebuilt at a cost of £711,000, and receives an annual subscription of £43,000. In rebuilding the University of Strasburg eight laboratories have been provided, so as to equip it fully with the modern requirements for teaching and research.* Prussia, the most economical nation in the world, spends £391,000 yearly out of taxation on her universities.

The recent action of France is still more remarkable. After the Franco-German War the Institute of France discussed the important

* The cost of these laboratories has been as follows: Chemical Institute, £35,000; Physical Institute, £28,000; Botanical Institute, £26,000; Observatory, £25,000; Anatomy, £42,000; Clinical Surgery, £26,000; Physiological Chemistry, £16,000; Physiological Institute, £13,900.

question, "Pourquoi la France n'a pas trouvé d'hommes supérieurs au moment du péril?" The general answer was because France had allowed university education to sink to a low ebb. Before the great Revolution France had twenty-three autonomous universities in the provinces. Napoleon desired to found one great university at Paris, and he crushed out the others with the hand of a despot, and remodelled the last with the instincts of a drill-sergeant. The central university sank so low that in 1868 it is said that only £8,000 were spent for true academic purposes. Startled by the intellectual sterility shown in the war, France has made gigantic efforts to retrieve her position, and has rebuilt the provincial colleges at a cost of £3,280,000, while her annual budget for their support now reaches half a million pounds. In order to open these provincial colleges to the best talent of France, more than five hundred scholarships have been founded, of an annual cost of £30,000. France now recognizes that it is not by the number of men under arms that she can compete with her great neighbor Germany, so she has determined to equal her in intellect. You will understand why it is that Germany was obliged, even if she had not been willing, to spend such large sums in order to equip the university of her conquered province, Alsace-Lorraine. France and Germany are fully aware that science is the source of wealth and power, and that the only way of advancing it is to encourage universities to make researches and to spread existing knowledge through the community. Other European nations are advancing on the same lines. Switzerland is a remarkable illustration of how a country can compensate itself for its natural disadvantages by a scientific education of its people. Switzerland contains neither coal nor the ordinary raw materials of industry, and is separated from other countries which might supply them by mountain-barriers. Yet, by a singularly good system of graded schools, and by the great technical college of Zürich, she has become a prosperous manufacturing country. In Great Britain we have nothing comparable to this technical college, either in magnitude or efficiency. Belgium is reorganizing its universities, and the state has freed the localities from the charge of buildings, and will in future equip the universities with efficient teaching resources out of public taxation. Holland, with a population of four million, and a small revenue of £9,000,000, spends £136,000 on her four universities. Contrast this liberality of foreign countries in the promotion of higher instruction with the action of our own country. Scotland, like Holland, has four universities, and is not very different from it in population, but it only receives £30,000 from the state. By a special clause in the Scotch Universities Bill the Government asked Parliament to declare that under no circumstances should the parliamentary grant be ever increased above £40,000. According to the views of the British Treasury, there is a finality in science and in expanding knowledge.

The wealthy Universities of Oxford and Cambridge are gradually constructing laboratories for science. The merchant princes of Manchester have equipped their new Victoria University with similar laboratories. Edinburgh and Glasgow Universities have also done so, partly at the cost of Government and largely by private subscriptions. The poorer Universities of Aberdeen and St. Andrews are still inefficiently provided with the modern appliances for teaching science.

London has one small Government college and two chartered colleges, but is wholly destitute of a teaching university. It would excite great astonishment at the Treasury if we were to make the modest request that the great metropolis, with a population of four million, should be put into as efficient academical position as the town of Strasburg, with 104,000 inhabitants, by receiving, as that town does, £43,000 annually for academic instruction and £700,000 for university buildings. Still, the amazing anomaly that London has no teaching university must ere long cease.

It is a comforting fact that, in spite of the indifference of Parliament, the large towns of the kingdom are showing their sense of the need of higher education. Manchester has already its university. Nottingham, Birmingham, Leeds, and Bristol have colleges more or less complete. Liverpool converts a disused lunatic asylum into a college for sane people. Cardiff rents an infirmary for a collegiate building. Dundee, by private benefaction, rears a Baxter College with larger ambitions. All these are healthy signs that the public are determined to have advanced science-teaching, but the resources of the institutions are altogether inadequate to the end in view. Even in the few cases where the laboratories are efficient for teaching purposes, they are inefficient as laboratories for research. Under these circumstances the Royal Commission on Science advocates special Government laboratories for research. Such laboratories, supported by public money, are as legitimate subjects for expenditure as galleries for pictures or sculpture; but I think that they would not be successful, and would injure science if they failed. It would be safer in the mean time if the state assisted universities or well-established colleges to found laboratories of research under their own care. Even such a proposal shocks our Chancellor of the Exchequer, who tells us that this country is burdened with public debt, and has ironclads to build and arsenals to provide. Nevertheless our wealth is proportionally much greater than that of foreign states which are competing with so much vigor in the promotion of higher education. They deem such expenditure to be true economy, and do not allow their huge standing armies to be an apology for keeping their people backward in the march of knowledge. France, which in the last ten years has been spending a million annually on university education, had a war indemnity to pay, and competes successfully with this country in ironclads. Either all foreign states are strangely deceived in their belief that the competition of the world has become a competition of intellect, or we are marvelously unobservant of the change which is passing over Europe in the higher education of the people. Preparations for war will not insure to us the blessings and security of an enlightened peace. Protective expenditure may be wise, though productive expenditure is wiser.

> "Were half the powers which fill the world with terror,
> Were half the wealth bestowed on camps and courts,
> Given to redeem the human mind from error—
> There were no need of arsenals and forts."

Universities are not mere storehouses of knowledge; they are also conservatories for its cultivation. In Mexico there is a species of ant which sets apart some of its individuals to act as honey-jars by monstrously extending their abdomens to store the precious fluid till it is wanted by the community. Professors in a university have a higher function, because they ought to make new honey as well as to store it. The widening of the bounds of knowledge, literary or scientific, is the crowning glory of university life. Germany unites the functions of teaching and research in the universities, while France keeps them in separate institutions. The former system is best adapted to our habits, but its condition for success is that our science-chairs should be greatly increased, so that teachers should not be wholly absorbed in the duties of instruction. Germany subdivides the sciences into various chairs, and gives to the professors special laboratories. It also makes it a condition for the higher honors of a university that the candidates shall give proofs of their ability to make original researches. Under such a system, teaching and investigation are not incompatible. In the evidence before the Science Commission many opinions were given that scientific men engaged in research should not be burdened with the duties of education, and there is much to be said in support of this view when a single professor for the whole range of physical science is its only representative in a university. But I hope that such a system will not long continue, for if it do we must occupy a very inferior position as a nation in the intellectual competition of Europe. Research and education in limited branches of higher knowledge are not incompatible. It is true that Galileo complained of the burden imposed upon him by his numerous astronomical pupils, though few other philosophers have echoed this complaint. Newton, who produced order in worlds, and Dalton, who brought atoms under the reign of order and number, rejoiced in their pupils. Lalande spread astronomers as Liebig spread chemists, and Johannes Müller biologists, all over the world. Laplace, La Grange, Dulong, Gay-Lussac, Berthollet, and Dumas, were professors as well as discoverers in France. In England our discoverers have generally been teachers. In fact, I recollect only three notable examples of men who were not—Boyle, Cavendish, and Joule. It was so in ancient as well as in modern times, for Plato and Aristotle taught and philosophized. If you do not make the investigator a schoolmaster, as Dalton was, and as practically our professors are at the present time, with the duty of teaching all branches of their sciences, the mere elementary truths as well as the highest generalizations being compressed into a course, it is well that they should be brought into contact with the world in which they live, so as to know its wants and aspirations. They could then quicken the pregnant minds around them, and extend to others their own power and love of research. Goethe had a fine perception of this when he wrote:

> "Wer in der Weltgeschichte lebt,
> Wer in die Zeiten schaut, und strebt,
> Nur der ist werth, zu sprechen und zu dichten."

Our universities are still far from the attainment of a proper combination of their resources between teaching and research. Even Oxford and Cambridge, which have done so much in recent years in the equipment of laboratories and in adding to their scientific staff, are still far behind a second-class German university. The professional faculties of the English universities are growing, and will diffuse a greater taste for science among their students, though they may absorb the time of the limited professoriate so as to prevent it advancing the boundaries of knowledge. Professional faculties are absolutely essential to the existence of universities in poor countries like Scotland and Ireland. This has been the case from the early days of the Bologna University up to the present time. Originally universities arose not by mere bulls of popes, but as a response to the strong desire of the professional classes to dignify their crafts by real knowledge. If their education had been limited to mere technical schools, like the Medical School of Salerno, which flourished in the eleventh century, length but not breadth would have been given to education. So the universities wisely joined culture to the professional sciences. Poor countries like Scotland and Ireland must have their academic systems based on the professional faculties, although wealthy universities like Oxford and Cambridge may continue to have them as mere supplements to a more general education. A greater liberality of support on the part of the state in the establishment of chairs of science, for the sake of science and not merely for the teaching of the professions, would enable the poorer universities to take their part in the advancement of knowledge.

I have already alluded to the foundation of new colleges in different parts of the kingdom. Owens College has worthily developed into the Victoria University. Formerly she depended for degrees on the University of London. No longer will she be like a moon reflecting cold and sickly rays from a distant luminary, for in future she will be a sun, a center of intelligence, warming and illuminating the regions around her. The other colleges which have formed themselves in large manufacturing districts are remarkable expressions from them that science must be promoted. Including the colleges of a high class, such as University College and King's College in London, and the three Queen's Colleges in Ireland, the aggregate attendance of students in colleges without university rank is between nine and ten thousand, while that of the universities is fifteen thousand. No doubt some of the provincial colleges require considerable improvement in their teaching methods; sometimes they unwisely aim at a full university curriculum when it would be better for them to act as faculties. Still they are all growing in the spirit of self-help, and some of them are destined, like Owens College, to develop into universities. This is not a subject of alarm to lovers of education, while it is one of hope and encouragement to the great centers of industry. There are too few autonomous universities in England in proportion to its population. While Scotland, with a population of 3,750,000, has four universities with 6,500 students, England, with twenty-six million people, has only the same number of teaching universities with six thousand students. Unless English colleges have such ambition, they may be turned into mere mills to grind out material for examinations and competitions. Higher colleges should always hold before their students that knowledge, for its own sake, is the only object worthy of reverence. Beyond college-life there is a land of research flowing with milk and honey for those who know how to cultivate it. Colleges should at least show a Pisgah view of this land of promise, which stretches far beyond the Jordan of examinations and competitions.

TWO WONDERFUL INSTRUMENTS.

By ALBERT LEFFINGWELL, M. D.

THE eye is the most wonderful organ existing in the higher forms of animal life. It is the window of the brain; through it, the creature obtains knowledge of that which lies beyond the reach of its other senses.

But there is really nothing very mysterious about the structure of the eye when considered as an optical instrument. It is simply a tiny chamber, with one little window through which light passes, making a reversed picture upon the wall beyond. The same effect may be obtained by a lens so fixed in the window of a darkened room that the only light from without must pass through it. As in the illustration we present herewith, the picture of the scene without, the peasant-girl afoot, the rustic laborer, the thatched cottage—all appear on the screen in the dark chamber, but reversed in position.

The same effect is produced by the eye. The eyeball is a little globular room. The window is so contrived that it can be made small or large, as the light is strong or feeble. From the wall in the rear upon which the picture is made, a nerve carries the impression back-

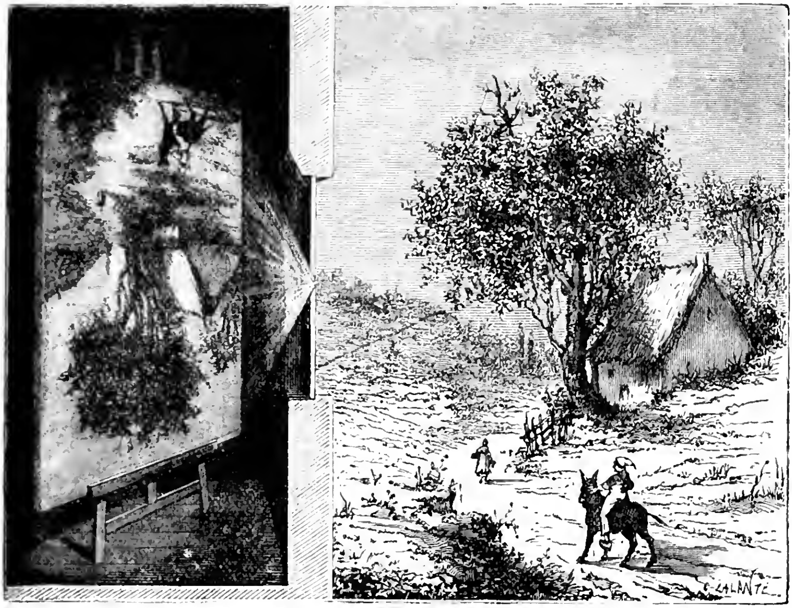

FIG. 1.

ward to the brain, and by means of that impression we perceive. This is the mystery, how the brain gets its impression ; not how the eye gets its image.

In the present article I shall not describe the structure and functions of the eye, except to show how human ingenuity has contrived an instrument almost exactly resembling it, and capable in some respects of doing far more wonderful work. Man has invented in reality an artificial eye which sees farther, with infinitely greater distinctness, and in a very much shorter space of time, nearly everything which lies before it. Almost every particular in the structure of the human eye must be imitated by this instrument. When in its most perfect condition its work is quite as wonderful as the eye of an animal.

In the first place, we must have a perfectly dark box, say about a foot high, a foot wide, and about eighteen inches long. This is the dark chamber, and corresponds to the eyeball. In one end is an opening in which is inserted a peculiar arrangement of optical glasses. These will correspond to that part of the human eye which is called the crystalline lens.

What is this ? Just in front of the main body of the eyeball, behind the curtain which we see, is a transparent, circular and flattened body, thicker in the middle and thinner at its edges, the exact shape of a burning-glass. It is held in its position by a very delicate membrane which suspends it in its place in front and behind. If it were not for this crystalline lens of the eye, we should be able only to have an indistinct impression of light. This lens enables us to see the forms of things; defining them in the same manner as the lens of spectacles, or the lenses of the telescope or opera-glass. Now, in the artificial eye which we are considering, we must place, in the front part, glass lenses through which the picture or view can pass into its interior.

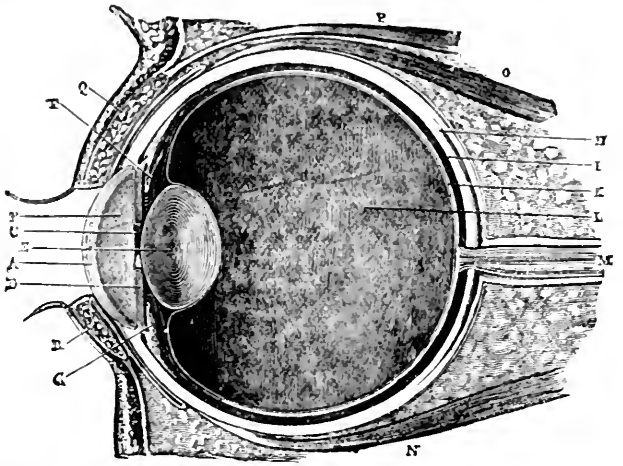

FIG 2.—A VERTICAL SECTION OF THE EYE.—*A*, the cornea; *E*, the crystalline lens; *I*, the choroid; *K*, the retina; *M*, the optic nerve leading to the brain.

In the human eye the entire inner surface of the eyeball is covered with a brownish-black membrane called the *choroid* coat. Its use is to absorb light which reaches it and to prevent reflections. Now, in our artificial imitation, we must cover the entire interior of the box with black paint, so as to absorb every ray of light, except that for which we have a use.

In the back part of the human eye is the termination of the optic nerve called the retina. It is that part of the eye which is especially sensitive to light; it receives the rays entering through the front window, forms a picture of the scene, and communicates the impression through the fibers of the optic nerve to the brain behind it. How it does this we do not know. It is certain, however, that an exact picture of anything we see is created upon this membrane in the back part of the eyeball.

Doubtless the reader has already guessed the name of the artificial invention I have been describing—the photographic camera. But what shall take the place of the nerve or retina of the eye? What shall stand in place of the mysterious cells of gray matter in the brain, which receive and retain the visual impressions? After all, this is the only really wonderful part of either instrument.

In modern photography that which answers to the retina of the eye is called a "sensitive plate." It is a small plate of glass, coated with a chemical solution, so sensitive to light that it darkens the moment it is exposed to the faintest ray of sunlight. Let us take one of these plates and, with due precautions, carefully put it in the camera exactly where in the human eye the retina is situated. The camera, or dark chamber, is covered in front exactly as though the eye were closed; not a ray of light under any circumstances is yet permitted to enter it.

Now comes the mysterious part of its execution. Let us suppose that a man blindfolded, and this artificial eye, a photographic camera, are set down in the open air in the bright sunshine before the scene of some great ceremony—a procession of a thousand persons, the moving panorama of a city street, or a wide extent of landscape. Suppose that, the bandage being removed, the man were instructed instantaneously to open and shut his eyes as quickly as possible, and then to describe what he had seen in that twinkling of an eye. What would be the result?

Try the experiment yourself. Go to the window, with your eyes closed. Open and shut them just as quickly as possible, and then try to describe what you have seen in that time. It will be very little, besides that which you remember from previous familiarity with the scene. For the most part there will be nothing beyond a confused idea of light and shade. The time of this momentary vision will be too short to enable the human retina to perceive or the human brain to register any definite impression of anything.

How is it with the photographic camera and lens, our artificial eye? We will suppose that everything is in readiness, that its retina or sensitive plate is in perfect condition, and that not a ray of light has yet entered within the darkened chamber. Instead of being "the twinkling of an eye," we shall arrange so that the time elapsing between the opening and closing of the artificial eyelid shall be less than one tenth of a second, or far less than the time necessary for our eyes to open and shut. It shall be as nearly "instantaneous" as possible. Everything is ready. *Click!* It has opened and shut. What has it seen in that little instant of time?

If anything is in motion, it has been perceived in that fragment of a second as if *motionless*. Men walking along the street are pictured with uplifted feet. A trotting-horse may be caught with all of its four legs in the air, viewed just at the moment when he was clear of the ground. A man leaping with a high pole may be pictured in mid-air, precisely in the position in which he appears at the highest altitude. Motion seems rest.

But this is not the most wonderful of its powers. Far beyond the keenest of human vision is its range of sight. If the light is good, this sensitive plate of glass will have recorded and discerned a thousand uplifted faces as perfectly as the human eye perceives the features of a single countenance. Every expression of joy or sorrow, every peculiarity of dress or attitude, the leaves of a forest or the grass by the wayside, will have been seen and delineated and retained perfectly in far less than the briefest possible twinkling of a human eye.

Before me as I write is an instantaneous photograph upon glass of one of the principal boulevards of Paris, taken about noon-time. I seem to be looking down a broad avenue of lofty houses, each six stories high. I can see seven street crossings or blocks. The avenue is lined with shade-trees on either side. The street is filled with a moving panorama. So exquisitely fine are all the details that, to bring them out, I must use a small hand-microscope. Nearly fifty vehicles of every kind are in sight, all in position of arrested motion. A block distant an omnibus is approaching; the very foot-board slats upon which a passenger rests his feet I can count with my microscope. The sidewalks are crowded with every variety of Parisian costumes. Near me is a soldier touching his hat to his superior officer as he passes him, and three blocks away I can see a man sweeping the street. School-boys and clerks, shop-girls and mechanics, soldiers and street-sweepers, gentlemen of leisure and rambling travelers, representing every type of Parisian life, are all here. It is a picture of a Moment of Existence. Ten minutes later, and it may be not a single person here represented will be walking or riding along this street, yet the scene itself will be unchanged. The crowd continues; the atoms change.

Here is another Paris view, of a spot infinitely interesting to the historian, the Place de la Concorde. Almost in exact range we see the two fountains on either side of the Obelisk of Luxor; a quarter of a mile beyond is the Church of the Madeleine. The same ever-moving crowd of human activities is here again unconsciously arrested on this plate of glass! There rises the Egyptian Obelisk, every hieroglyph as clear as when first raised in Egypt two thousand years ago. Ah! if human invention could have caused this eye to preserve for us but one glance of the awful tragedies which have been enacted on this spot! In place of those romping school-boys or laughing sight-seers, once gathered on this place an eager, hungry, and bloodthirsty crowd of men and women; where that obelisk points to heaven once stood a platform, and thereon the guillotine. And one day this arresting eye might have seen Louis XVI, bending his head to the axe; and another day caught Marie Antoinette's look, as she glanced backward toward the Tuileries; or Madame Roland apostrophizing the Statue of Liberty; or Charlotte Corday murmuring, "The crime, and not the scaffold, makes the shame!" And imagine the upturned faces of *that* crowd!

But not only is the range of vision vastly more comprehensive by the photographic camera; it is far keener. The sensitive plate of the photographer is to-day of special use in the observatory of the astronomer. Far out in infinite space are stars which the human eye, looking through the most powerful telescope, fails to see; they are beyond its range. Yet this simple plate of glass can see them. It has a power beyond that of any human retina! Dark spaces, once considered blank, are to-day known to be full of suns, each perhaps with its retinue of planets, filled it may be with beings like ourselves.

The future possibilities of this wonderful invention are beyond conception. It may be that for centuries hence, before war ends, and civilization triumphs in peace, the instantaneous photographic apparatus will be a part of every army equipment. There is no reason why a great battle could not be taken—aside, perhaps, from smoke-obscurity—as well as any great concourse of people. To-day the photographic artist is content to catch the movements of a race-horse or an athlete, or the panorama of a city crowd; then, perhaps, our distant posterity will be only satisfied with the instantaneous record of more important events. To-day, history is made up of confused and disputed statements; then, it may be read in the living pictures of the deeds themselves.

A FREE COLONY OF LUNATICS.

By HENRY DE VARIGNY.

THE celebrated Belgian colony of the insane at Gheel has nothing in its external appearance suggestive of the ordinary lunatic asylum; its inhabitants give no superficial indications that a large proportion of them are madmen.

If one would conceive what Gheel is, he must imagine a town of five or six thousand souls, in no way different from other towns of like importance, surrounded by a number of hamlets containing altogether, perhaps, about as many more inhabitants. These people have been, from a very remote period, in the habit of taking insane persons to board in their houses. The lunatics live in constant contact with the family of their host. They share in their labors and their pleasures if so inclined and their means permit it. They come and go, in the enjoyment of an almost absolute liberty. It has, however, been found necessary for the good of the patients and of the settled population to organize administrative and medical services, in order to prevent dangerous and improper persons from being sent to the colony, and for the care of the mental and physical affections of the patients, and for securing to them proper accommodation and treatment; and an infirmary has been established for those who need medical care. But the administration makes very little show. The whole of the Gheel district is an asylum; and the streets and the surrounding country are the promenade of the lunatics.

The origin of this unique institution is derived, according to the legend, from the daughter of an Irish king, named Dymphne, who, about the end of the sixth or the beginning of the seventh century, took refuge at Gheel, with her confessor, to escape the incestuous solicitations of her father. The king pursued his daughter and found her, by keeping track of the coins the fugitives had paid out. The confessor was assassinated by the soldiers, and Dymphne was decapitated by her father himself. Dymphne in time became a saint, but how her chastity made her the patron of lunatics is not explained. Her memory has been preserved at Gheel through all the centuries that have elapsed. The well is shown where she went to draw water, and the house whose mistress gave the king the clews by which he found his daughter; a chapel was erected in honor of this virgin, and as a memorial of the circumstances under which she perished; and a large church consecrated to St. Dymphne was built some centuries ago. These circumstances have made Gheel a center of pilgrimages, and the resort of the insane from a period very far back. The unfortunates were lodged on their arrival in a building appertaining to the church, called the invalid-chamber, which still exists. They stayed there nine days, attending the religious services and prayers for their cure through the intercession of the murdered virgin. Sometimes they stayed another nine days. It was hard to send them away uncured; but other unfortunates would be there waiting for their turn, and there was not room for all. Rather than dismiss them summarily, they were put in the care of some family who would undertake to bring them to the special services every day. At first the patients were kept in the immediate neighborhood of the church, or within its parish jurisdiction; but they became in time too many for that, and were scattered over the neighboring villages. A service of public administration was gradually organized, the history of which, and of the modifications it has undergone, would be interesting if we had room to give it.

The earliest recorded regulation is of 1676, and directs that the proper officers shall order all persons having charge of the insane to bind them hand and foot, so that they can not harm any one, and that they shall prevent their going into the parish church of St. Armand, under penalty of a fine of six florins. In 1747 ordinances were passed that no insane person in fetters should go into the church of St. Armand or St. Dymphne unless accompanied by his *nourricier*; that no lunatic should be bound without the previous knowledge and permission of the reverend collegiate dean or of the bailiff; and that Catholic *nourriciers* should invite the clergy to examine into the mental condition of their patients, to ascertain whether they were fit to receive the sacraments. In 1754 a new ordinance, declaring that the lunatics had too much liberty and could not be distinguished from rational persons, directed the *nourriciers* to keep them secure, by fetters, or by shutting them up, or in some other way; that they should pay for all damage caused by their patients; and that lunatics should not go out before a fixed hour in the morning, and should return by a fixed hour in the evening. They were also prohibited from using fire, even to light their pipes, outside the house of their *nourricier*. An ordinance of 1790 directed the police to take precautions against damages by lunatics and by mischievous and dangerous animals. The medical service was instituted in 1838. The control and administration of the colony passed from the communal organization to the state under the law of June, 1850; and in the next year they were placed under the special direction of a commission whose composition and functions were strictly defined. In 1874 the communal authority was deprived of what little part in the nomination of members of the commission had been left it under the law of 1851.

The present system dates from 1882. It confides the inspection and surveillance of the patients to a superior commission, consisting of the governor of the province or his delegate, and a number of responsible local officers. To this commission—all of whom except one, a physician appointed by the Government, are *ex-officio* members—is added a "secretary receiver," appointed by the Minister of Justice, who is the real executive officer or director. The superior commission is charged with the general care of all that concerns the patients. It reports yearly on the reforms which seem to it to be needed; watches that all the regulations are enforced; and keeps the list of persons authorized to receive patients. It is supplemented by a permanent committee, at the head of which is the burgomaster, whose business it is to care for the interests of the lunatics, to look after the expense of boarding and taking care of them, to inspect their boarding-places, and to attend generally to the execution of the regulations. There is also a lodging committee, whose business it is to secure places for patients whose families, or the local boards by whom they are sent, have not already provided homes for them. Furthermore, the administration includes the very modest but very important guards of sections, appointed by the Minister of Justice, who are brought into more immediate contact with the patients than any other of the officers. They bear the administrative and medical orders wherever they are to go: they constantly go over the section to which they are attached, visiting the patient's lodgings at any time, and insisting on his room being shown to them at a moment's notice, and on seeing the patient himself if he is at home. They see that the patient is properly clothed, that he does not work too much, that his room is well kept, that he has suitable food; they report cases of sickness, help take the sick to the infirmary, and see that the medical prescriptions are respected. They also see that the patients are at home at the appointed hours, and have to put down any disorder of which a patient may be the occasion or the object.

Since 1882 Gheel has been divided into two distinct and entirely independent sections of medical administration. At the head of each is a doctor-in-chief, assisted by an adjunct physician. The medical service comprises treatment of the patients for their mental affections and the incidental maladies attending them, correspondence with administrations or families, concerning their moral and physical condition, the direction and observation of the guards of section in all that concerns the medical service, surveillance of the *nourriciers* in points regarding the hygiene, food, and lodging of the patients intrusted to their care, and as to their own conduct and devotion to the welfare of their wards. The curable lunatic must be visited at least once a week by the doctor-in-chief or adjunct doctor of his section. The incurables are visited once a month. The doctors meet monthly and consider what reforms and improvements may be introduced into the service.

The infirmary was built in 1862. It is divided into two sections for the separation of the sexes. It is directed by an adjunct physician under the control of the doctors-in-chief, who have severally the control of half of each section. To it are admitted patients, the precise diagnosis of whose cases has not yet been made, who remain a few days for observation before being put under the care of a *nourricier*; patients already placed who show some disquieting symptom, and those who are suffering from some incidental affection. The sick are visited here twice a day. Besides the adjunct physician, two guards of section, a sister, and the necessary subordinates, are attached to the infirmary.

Gheel is situated twenty-six miles east of Antwerp, and is reached from it by railroad. It is the chief town of the Campine country, and, with the territory administratively dependent upon it and also receiving insane, gives about 11,000 inhabitants, occupying some 25,000 acres. It is easy to distribute 1,600 insane over such an extent of territory without their coming into frequent contact with one another. According to the act of 1882, insane persons may be received at Gheel of all classes except those upon whom means of restraint and coercion have to be employed continuously; those inclined to suicide, homicide, and incendiarism, and those who have made frequent escapes, or whose affections are of a character to endanger the public tranquillity or to offend public decency. After his arrival, the patient usually passes some time at the infirmary, where he is examined and studied by the physician. If his diagnosis has already been made, it is confirmed or modified; if not, he is kept till an exact idea is gained of the nature of his affection, and it is decided whether he belongs to the class of those who can be allowed to remain there. His words and movements are carefully noted, and his case soon becomes understood. If he is found to be inoffensive, the next business is to place him in some family.

The register, on which are inscribed the names of all the *hôtes* and *nourriciers* of the commune, is then consulted. The *hôtes* (hosts) are those who take lunatics as boarders; the *nourriciers* (fosterers) those who take indigent insane. As a rule, each *hôte* or *nourricier* is expected to take only one patient; but many exceptions are allowed, and a liberal construction is indulged in. The food is usually about the same as that of the family with which the patient lives; consequently, the comfort of the latter is to a large extent dependent on the pecuniary condition of his host, though the price he pays for maintenance may be the same. In this point the close asylums, where the table-provision is uniform, or is varied according to a system, may have some advantage over Gheel; but this advantage is probably more than offset by the freedom of the open air and exercise, and the country life which the sojourner at Gheel enjoys.

The air capacity, the furnishing, the cleanliness, and hygienic condition of the patient's lodgings are carefully provided for in the regulations and secured by the inspections-at-will of the sectional guards. Patients able to pay a larger than the usual price can secure quarters to suit them; then the administration, being informed of the stipulations of the bargain that has been made for them, see that they are carried out. The board, whether of the self-paying or of the indigent patients, is paid through the permanent committee. The price of board is fixed anew at the beginning of each year. It is not absolutely uniform for any class of patients, but is subject to variation, according to the particular circumstances that may exist.

A considerable responsibility is incurred by those among whom a lunatic is put to board, and in many instances the position of his guardians is no sinecure. They are at once furnished by the administration with a register, in which are recorded his name, age, sex, civil state, and profession; and in this register the physician, inspector, and guard of the section have to enter their names every time they visit the patient, with such notes as will constitute a kind of history of the case and a financial account-current.

The *nourricier* has to answer for all the waste and damage his patient may commit, and, together with the guard of the section, is held responsible if he escapes; and he is liable to punishment in case he allows himself to commit any act of violence or hardship against his ward. Only in case of extreme danger from a raving lunatic is he permitted, in self-defense, to exercise restraint upon him. The physician has the sole right to prescribe coercive measures. Like all other institutions of the kind, Gheel has passed through a period when measures and instruments of coercion were freely employed; but they are disused now, here as elsewhere.

Instances occasionally occur where the attendants use force toward the insane, but they are made cases for discipline. It is to be observed, with reference to this question, that each patient at Gheel has not one or two only, but several thousand persons observing him. In a close asylum, a very small number of guards are sufficient, with the aid of the high walls and gratings, to watch a relatively large number of insane; but there the patient is not watched by any except the guards. While cases of maltreatment are rare, they nevertheless occur, and have to be brought into the courts. But this is hardly possible at Gheel; here is a whole population directly or remotely interested in seeing that the patients are well treated. The *nourricier* always has rivals who would be eager to take advantage of any case of violence or brutality to denounce the culprit and have his license withdrawn. Every inhabitant of Gheel is or can become acquainted with all the members of the colony; he knows where they live, and understands the phases of their various affections, and has a sympathy for them. Where else could be found so many guards and so well trained? But the number of guards of section is not in proportion to the importance and multiplicity of their duties, and it should be increased. Four men are not enough to attend to all the details that fall under their supervision; and cases may occur, as has sometimes happened, when they are all at once occupied, or absent, on special duty.

Once placed with his *nourricier*, the patient enjoys considerable liberty. If he is wealthy, or in easy circumstances, he does what he pleases; he may read, write, smoke, and work, according to his inclination; the poorer patient, also, if he does not care to work, may pass his time in his own way. But, except when an indigent patient is too old to labor, or when physical infirmities forbid his exercising any manual profession, the large majority of the patients at Gheel are employed in some way or another. Work, especially field-work, agrees well with the insane. It gives them a salutary diversion. In a purely physical view, it has always the advantage of strengthening their muscles and promoting an energetic circulation of the blood; but the benefit in this case is perhaps more moral than physical. The proportion of patients employed at Gheel varies according to the categories of their affections, but may be averaged at about seventy-two per cent, and is nearly equally made up of men and women. According to an estimate furnished by Dr. Peeters, in a group of 390 maniacs are 178 men, only 30 of whom are idle; the rest are at work as follow: 25 at housekeeping, 110 in agriculture, and the rest as masons, fishermen, brick-makers, draughtsmen, carriers, shoe-makers, joiners, or tailors. Among the idiots, we find 182 employed, 84 unemployed; among 62 melancholics, 44 engaged in some kind of work, and 18 not so engaged. A considerable number of professions are represented among the insane men, and those who desire to work at their regular business can do so. With the women, while the number of professions is smaller, the number who are occupied in one way or another is more considerable than among the men; the majority of them assist in the housekeeping or in taking care of the children; many work in the fields; a few carry on a trade, lace-making, for instance.

The capacity to do profitable work varies among the different classes of patients. Idiots, according to Dr. Peeters, make efficient laborers, unless their disease is too far advanced. To prevent abuse, it is stipulated that the *nourricier* shall not decide on his own responsibility whether his patient shall work or not; that is determined by medical permission or prescription. The patients are apt to work too much. They become interested in the occupations of the family and follow them to the fields, unless they are prohibited by the physician, and are in this way often tempted to do the full day's work of a strong man—sometimes, possibly, to their harm. The compensation they receive depends, of course, upon the work they do. Sometimes they receive a small sum at the end of the week; sometimes they are paid in tobacco, eggs, beer, or articles of clothing. But the administration takes care that they get something, either in the form of a present or as regular pay.

The regulations of internal discipline imposed on the patients are very simple. They can go out between eight o'clock in the morning and four o'clock in the afternoon in the winter, and between six and six in the summer, and at other hours by special permission. Only quiet patients can resort to the inns, and it is forbidden to give spirituous liquors to any of them. If the patient does not desire to work, he can indulge his taste for reading or art; in pleasant weather he can go to Gheel or walk in the country, alone or with a friend; but he is not allowed to travel on the railroad or to go away.

The question is in order of the effect of this liberty upon the personal security and the health and morality of the population of Gheel.

Suicides are very rare; there has been only one since 1879; there were three between 1875 and 1879, and others in 1850 and 1851. No act of violence has been recorded since 1878. But such things have occurred, as when, in 1844, the burgomaster, who was also a druggist, was assassinated by an insane herbalist, who imagined him his rival in trade. Dr. Peeters can recall only three cases of crime in a very long time. The personal security of the lunatics is sometimes compromised by the dealers selling them liquors. The fact is always a grave one, for it implies a deficiency in the surveillance. We have already said that four guards of section are not enough. More are needed, to watch those who have their senses, as well as those who have lost them. In this way only can some of the objectionable features inherent in the mode of life carried out at Gheel be eliminated. Escapes are by no means rare. Sixty-six cases occurred in the six years, 1876–1881, or an average of about nine a year. Whenever a patient betrays an inclination to run away, instead of being subjected to measures of coercion, he is usually sent to a close asylum. It is a fact worthy of remark that, in nine cases out of ten, attempts at escape take place on Sunday. This is usually because the *nourriciers* go off and amuse themselves on that day, and leave their patient to take care of himself; when, with nothing to do, or with which to occupy his mind, and in his timidity and strangeness, the idea of escape is apt to take possession of him. The remedy for this is simple: the patient has shared the occupations of the family during the week, now let him share their diversions. Although Gheel is not a place of dissipation, there is no lack of diversions there; and there is no reason why the lunatic, being invited to participate in them along with the others, should not be made to feel at home in the colony, and become attached to it.

A doctor of laws, who had had several attacks of insanity, and had passed sixteen months in a close asylum, came to Gheel in 1871. His host took pains to procure diversions for him, and frequently engaged him to assist in the concerts of the musical circle of the town. He took great pleasure in this recreation, so that, in 1872, when he was cured and at liberty to go away, he chose to stay in Gheel with his musical circle; and nothing but an official appointment in another city could induce him to leave the place where he had had so much enjoyment. The Harmonic Society was founded near the beginning of this century by a lunatic named Colbert, a musical artist, with another insane musician and a friendly amateur, and has Colbert's portrait in its hall.

A few unpleasant features, from the moral point of view, are produced through the constant intermingling of the insane with the normal-minded population. There have been half a dozen cases of pregnancy among the insane within fifty years; two of them since 1880. Some of the patients also will occasionally manifest their passions in an obscene manner; but, whenever they do so, they are sent to a close establishment as soon as possible, and are in the mean time confined in the infirmary. Generally, however, so careful discrimination is exercised in sending patients to Gheel, that it is rare to find among them any who are dangerous to public morality. It has long been usual for persons to come to Gheel for a temporary sojourn; and these are mostly deranged. They are not under the control of the administration, which has no right to interfere with them, except in case of scandal or danger; and they come and go without surveillance. Many of them, according to Dr. Peeters, may be regarded as dangerous, and likely to abuse their liberty; and the doctor cites some particular instances to prove his position. These are the persons who commit most of the immoral acts, and it would be wrong to hold the colony responsible for their misdeeds. The value of the system pursued at Gheel can not be justly estimated by the proportion of cures obtained. The colony makes no pretense to be a substitute for the close asylums. The administration, agreeing with alienist experts, recognizes that there are some forms of insanity for which the close asylum is the only possible resort. Therefore, only certain classes can be sent to Gheel, and among these the number regarded as curable is very limited. In fact, the Belgian asylums send their incurables here so far as they can; and of the whole number of patients cared for, seventy-eight per cent are classed as incurable. The system works unfavorably for the colony relatively in a double way—by diminishing the number of failures to cure in the close asylums, and by correspondingly increasing the number at Gheel. Undoubtedly, the *régime* at Gheel is favorable even to incurables, but it is more so to curable cases, and it is to be regretted that the colony is not put in a position to make a more obvious proof of it. The proportion of deaths is raised in appearance by the same cause. From 1860 to 1875, the proportion of deaths varied from five to ten per cent, rising to the latter figure only twice. Such proportions are not, however, exaggerated, and, if we consider the hopeless character of the disease of the majority of the patients, we shall find that Gheel, if it can not heal incurables, keeps them in life and health for many years.

The insane population has recently increased very fast. In 1840 there were 717 patients; in 1855, 778; in 1866, 1,035; in 1872, 1,118; in 1879, 1,383; in 1883, 1,663. The increase is partly owing to the growing willingness of the people to receive patients, and partly to the improved administrative and medical service, which makes it more obvious that, with their liberty, persons sent there will not be uncared for. As to nationality, most of the patients are Belgians; after whom come Dutch, a few French, and fewer Germans and English. Among the cases are some who have passed most of their lives at Gheel. One is recorded as having died after a residence of fifty years; another stayed there fifty-two years; and residences of from forty to fifty years are not rare.

In what does this family treatment consist? The lunatic is taken from his habitual environment, from the society of those among whom he fell ill. They exist for him only in memory; they are not there to remind him continually of a melancholy subject, and to keep up the current of ideas in which he is involved. A new life is opened before him, with new faces, in a new country; everything is a subject of distraction to him; and, on the other hand, he has not the continual feeling that he is in a close asylum, with a door he can not pass through, and a wall over which he can not look. He is not in perpetual contact with lunatics, and is not subjected to a depressing influence. He enjoys the privilege of physical activity, and of life in the open air with sound-minded people, who are all the time diverting him from his preoccupations. He has even little children asking him to amuse them, and winning his attention, in spite of himself, perhaps, from himself. He is part of the family; they become attached to him, and he becomes attached to them. No one laughs at him, no one mocks him, he is never the object of any kind of demonstration, but all take him for what he is, an innocent. That is the family treatment at Gheel—isolation without solitude.

We add a few notes of our own visit to Gheel, which we made on two days in the spring of 1883. We arrived there, by railway, in the same train with a mother who was bringing her idiot son—a lusty youth, twenty years old—to leave him there. We found a town with wide streets, not entirely regular, and poorly paved, with few people out. The houses, two or three stories high, appeared well kept, with glistening window-panes and brightly polished door-knobs. Passing the grand square, near the church, we met a man about sixty years old, walking slowly along, with a baby in his arms which he was trying to entertain with a most discordant song. He was a patient, taking care for an hour or two of his host's child. He performed his duty faithfully and diligently, bidding good-morning to such persons as he knew, and exchanging a few words with them.

A few steps more brought us to the wide, tree-bordered avenue on which the infirmary is situated. The building is a handsome structure of brick and stone. We sought out Dr. Peeters, and after a few moments of conversation were authorized to visit the institution, and then, in company with a guard of section, to inspect the city and some of the houses where insane are entertained. The infirmary was throughout a model of Flemish neatness, with well-scoured floors and flagging, bright kitchens, and abundance of air and light. The sick-wards are in front. We paid a rapid visit to the women's quarter. Some were in the dormitory, some walking in the halls. Among the former, some of the more seriously affected ones were plaintively muttering words that we could not catch, others were grieving over the persecutions of which they imagined themselves the objects; another, of pleasant appearance, and fluent in conversation, answered all of our questions with suavity. She was delighted to receive our visit; the only thing about it that troubled her was to see our head some sixty feet above our body, and she could not but be surprised at it. She was well treated, and desired nothing better than her present condition. Thence we went into the garden, where we found two sisters, both hysteric, waiting their transfer to a close asylum. One had a dangerous propensity to homicide, and the other was subject to a depravity of manners that made it improper for her to be at large.

Our first visit, in company with a guard, to the boarding-houses, was at the comfortable dwelling of a well-bred lady, who was entertaining an Englishman and a Pole. We found the Englishman in his room, a bright and spacious apartment, sitting on a sofa, with his head between his hands. Our efforts to engage him in conversation, even in his own language, were vain. He answered sulkily, and ended by muttering that he was tired of us. Just as we were going out, the other patient came in, returning from a visit to a friend. He was a Polish prince, bearing a great historical name, but suffering from weakness of mind and occasional delirious fancies that he was an object of persecution. He was a man of excellent education, with the experience and manners of a man of the world, of fine build and well dressed. He paid the honors of the house to us with the greatest politeness, and declared that he was well satisfied to be at Gheel, saying, "I am a little deranged, and the quiet of the place does me a great deal of good." He had not the least desire in the world to go away. His wife had been there a short time before to take him to the sea-shore for a little while, but he would not go. It was not still enough there, and the life of the world would worry him.

On the road we met another lunatic, whose monomania was to go every day to the railway-station for a case of wine that he was expecting. It had never come, but the porter would always answer his questions hopefully, and he would go away satisfied, to repeat his errand the next day. Walking is one of the man's principal diversions.

We next visited the home of a peasant who had the care of two indigent insane women. One of them was sitting near the stove, much depressed, and silently weeping. The children of her hostess were playing at her feet, while the mother was attending to her household duties. The other woman was assisting the mistress of the house. Going out, we met a portly, dignified gentleman, who imagined himself to be a general. He entered into conversation with us. "Don't you know, Gheel is a very pleasant place? There is plenty of society here, and very enjoyable. Yes, it is good to be here. The air is pure and the life is quiet. I love it!" This man was sent here, several years ago, alone and unattended. The story goes that on reaching some city on the way, the police asked to see his papers. The "general" showed the certificate of insanity, which the physician who sent him to Gheel had given him, and the order for his admission to the colony. The *gend'arme* was not satisfied with these papers, which did not correspond with his routine, and asked for others. The "general" answered, with dignity: "I am mad; you see that from my papers. They have sent me to Gheel; let me alone, and I will go on!" He was at last allowed to proceed. He looks upon Gheel as a town where numbers of people come to take board to calm their nerves, and declares that the idea is an excellent one. Farther on we met two French lunatics. One, from Saint-Brieuc, had found things so comfortable at Gheel, that, having been restored to his family after getting better, he became discontented, and came back all alone, to join the colony again. The other one was a musical amateur who regularly attended all the concerts. The next case was a little woman about forty years old, a fluent and proper conversationist, who lived in constant expectation of her lover, who was to marry her as soon as he came, but that would not be till a railroad was built direct from his village to Gheel. She seemed to bear herself very cheerfully in her waiting. She had been discarded by her lover.

We next saw an English architect and water-color painter, who had been ruined by American whisky. He complained of being watched, domineered over, persecuted, and shut up, and asked me for a consultation respecting a host of imaginary ills with which he believed he was afflicted, and which the medical inspector could not cure. When we asked him how he passed his time, he showed us a portfolio of exceedingly well-executed water-color views of landscapes of the region, of wonderful perspective and remarkably good shading, and which he held at a very high price. He would often go many leagues to find a new view or to draw one, in odd contradiction to the complaints he made about restrictions to which he was subjected. He was also writing a great book, "a work of real genius" he called it, against monarchical government and in favor of the republic. A lady from Antwerp, deranged in consequence of some domestic troubles, who was domiciled in a commodious, cheerful, and well-kept house, talked on the afflictions of women, the thousand ways men had of tormenting them, the troubles of life, and the blessing of death, and repeated continually, "We must be resigned, we must live in hope." She nevertheless had a cheerful air and a pleasant and smiling face. Most of our second day at the colony was spent at Oosterloo, one of the most distant of the villages at which patients are taken. Our first call was upon a former "utility-man" of some theatre. We found him alone, in one of the back rooms, churning. He stopped when he saw us, greeted us, and performed the honors of the house. He had a plainly accentuated fancy that he was an object of persecution, and was under restraint. Yet nothing was easier than for him to go out and try to escape. There was nobody else in the house, and no one in the country would be surprised to see him walking around Gheel. His talk turned on the wonderful successes he had enjoyed in the theatre, and the malicious rivalries of his comrades who had put him down. At other houses we found a young man whose disease took the form of frequent explosions of laughter; one who was expecting to rejoin his sweetheart who had jilted him; old men in the kitchen sorting potatoes; and an old man who had a stock of wonderful stories, and boasted much of the marvelous cures he had performed of various diseases.

Our last call was at Gheel again, on a captain of artillery, who in answer to our greeting replied: "I am not here—only my body is on the earth; my soul has been in heaven, in the company of the blessed, for twenty-nine months and three days." Then, turning to my wife, "You appear, madam, in the likeness of the corpse of an aunt whom I lost a long time ago, but whose soul I meet in heaven; her earthly body was like yours." We remained for some time with this man, who spoke on other subjects with a fluency that reminded us of a well-oiled steam-engine going under high pressure. He had curious theories about death, prayer, and many analogous subjects. He declared that the Protestants and the Jews were sure of eternal flames, and condemned to the same punishment numerous other persons, beginning with his hostess, whom he accused of the most abominable outrages, among them of pouring melted lead into his head; while the woman listened to his vagaries with a smiling and motherly calmness. The poor man had become deranged after losing his wife, about ten years before.

The houses in which these patients were domiciled were all, even the most humble ones, of comfortable capacity, light, airy, cheerful, and well kept. Our general impression was that in some cases larger or better-ventilated rooms might be desired for the indigent patients, but that there was a general tendency toward improvement; and that this will come in time, by the force of circumstances, without its being necessary to make special new regulations. The clothing of the patients appeared sufficient and suitable; and their food was evidently nothing else than the food of the family. It would be exaggeration to say that perfection has been reached at Gheel, or that the medical organization and surveillance are all that they should be. Criticism is not out of place there, and there is room for reform. That very great improvements have been made during the last thirty years may be attested by reviewing the debates that have taken place in the Belgian Chambers, since 1850, concerning the condition of the colony. In one of the later discussions, M. Vleminckx said—and his remarks apply to the present condition: "Can any one mention an establishment that combines all the advantages to be found at Gheel? There is none such, and there can not be, for it is not enough to say, we will go somewhere and get so many acres and establish a new colony. No, no, more is needed than that. To make a colony like that of Gheel, we must have inhabitants like those of that place, who will not object to living a family life with lunatics, and who have accustomed themselves to such a life from generation to generation for hundreds of years."

Dr. Peeters, who is thoroughly acquainted with the colony and its needs, deeslare that no fundamental modifications are required. The system has worked for several centuries without trouble; and only minute improvements are wanted here and there in the machine as a whole. The most important matter is to increase the number of guards, who would now be wholly insufficient in case of any emergency. The medical service also should be assured a sufficient compensation to justify the doctors in giving up everything else, to devote themselves wholly to their duties here.

The principle that rules at Gheel is certainly more humane than any that prevails in close asylums, but it is applicable only to particular forms of mental alienation. Provided the patients to be sent there are judiciously selected, the possible inconveniences and abuses of the family *régime* are a small matter compared with the advantages which the lunatics may derive from it. Possibly some of the existing little abuses will never wholly disappear; but do not and will not such abuses exist everywhere? What great wrongs can exist there, in a colony exposed to all eyes, where ten thousand inhabitants are directly or indirectly interested in its good reputation? The colony has been developing for centuries. Let the modifications in detail suggested by science, by experience, by the desire to increase the safety and comfort of the patients, be applied to it. Nothing can be better or more humane than that; but such improvements need not touch the principle of family treatment.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE ART OF INVESTING.

By JOHN F. HUME.

"HOW can I invest my money to make it pay a fair interest, and at the same time insure its safety?" is a question daily asked by thousands. With the multiplication, consequent upon the growth of wealth among us, of that class of persons who want to live by their means, without care or labor, the number of anxious inquirers on that point is constantly increasing. It would seem, when reference is had to the many securities, both bonds and shares, that are offered, often at temptingly low prices, to be a question very easily answered. The truth is, there is none more difficult. The ordinary investor who goes about the work of converting his cash into paper combining the two elements of value spoken of, finding himself hopelessly embarrassed by the seeming richness of the market, soon gives up in despair, and turns the job over to some banker or broker who works for a commission. Experience shows that even then he is too often the victim of defective judgment or misplaced confidence.

A history of investment securities would furnish a most interesting study. In no other department of business have there been greater changes. The time has been, within the memory of many now living, when the man who had money to put at usury, generally loaned on personal indorsement, the borrower relying on his neighbor or other good friend to "back" his paper for him. The mortgage on real estate, of course, was known; but, owing to the short intervals for which loans were usually made, was not often resorted to. The shares of banking, turnpike, canal, railway and other incorporated companies after a while began to absorb the money of people who wanted to realize more than current rates of interest, and were willing to take corresponding risks.

The war of the rebellion popularized the coupon bond, in consequence of its adoption by the Government, and made it the favorite form of investment paper. Railroad and other corporations lost no time in availing themselves of the confidence which that species of debenture inspired, and States, cities, counties, etc., were soon flooding the country with obligations carrying long coupon attachments. Except for government and municipal uses, there never was a more disastrous invention. It has been the means of numberless deceptions, and has inflicted heavier losses upon the investing public than all other devices combined. Being supplemental to stock certificates, it has duplicated representatives of the same values and led to excessive issues of paper; it has separated capitalists from the management of properties into which their moneys have gone; and, being based upon mortgages promising absolute security, it has too often accomplished the grossest deception. Many a man has purchased and paid a good price for a mortgage coupon bond, giving him no control over his security, who would have rejected a share-certificate standing for an equal interest in the property pledged, and giving him the right to participate in its management, with the possibility of a greater return for his money.

Under the careless legislation of many of the States, which has permitted corporations to decide for themselves the amounts of obligations they might put out, it is no wonder that the privilege has been abused, and the making of shares and bonds, the latter represented to be amply secured by mortgage liens, has been carried to criminal excess. One illustration will suffice. The Arkansas Central Railroad Company (the name indicates the locality) built only forty-eight miles of its projected line. The road was of narrow gauge, with very light iron, and in every way cheaply constructed. It cost less than ten thousand dollars per mile, including equipment. As with most companies building railways in new countries, help in its behalf was asked from the communities to be benefited, and bonds amounting to nearly half a million dollars were given it by counties, cities, etc. Under a statute providing for aid to railroads when their beds could be utilized for levee purposes, the company got $160,000 of State bonds. Under another statute, it got, as a loan from the State, its bonds to the amount of $1,350,000, which were to be a first lien upon the property. After such abundant assistance, it would have seemed hardly necessary for the company to put out obligations of its own. However, it proceeded to issue and market its own bonds to the amount of $2,500,000, of which $1,200,000 purported to be secured by first mortgage, which was not the case. In addition, a considerable amount of stock certificates was issued. Altogether, nearly $5,000,000 of paper were put out and negotiated on the basis of forty-eight miles of narrow-gauge road. But this proved to be insufficient. The road, for non-payment of interest, soon passed into the hands of a receiver, who found it in such an unfinished state that, with the court's permission, he issued a considerable amount of his own certificates to provide for necessary repairs and betterments. Then the road—the product of so much outlay—was sold at public auction, and brought the magnificent sum of $40,000, which was paid, not in cash, but in receiver's certificates that had been purchased at a large discount!

That the foregoing case was not a solitary one, nor so exceptionally bad, might be inferred from the fact that the president of the railroad company, who managed its business, and was understood to be its principal beneficiary, was afterward elevated to the United States Senate, and is said to have been offered a seat in the Cabinet of one of our Presidents.

The business referred to has not been confined to railroads. We now have stocks and bonds upon the market representing nearly all conceivable kinds of property—telegraphs, telephones, mines, cattle-ranches, grain and grass farms, water-works, electric lights, factories and mills of every description, steamboat lines, and apartment-houses. There seems to be no limit to their production. There never was a time when it was so easy to invest money—and to lose it. Of the securities that are offered with first-class recommendations, it is probable that about one third are actually good, one third have some value, and one third are practically worthless.

For the condition of things described, the laws of our States, in giving corporations almost limitless power to issue negotiable paper, are, undoubtedly, very largely to blame. Our banks are closely watched and restrained from taking people's money on false pretenses; but how much better is it for railway and other corporations to take it by means of legalized fictitious evidences of value? Banks are by no means the only corporate institutions that need watching. One of the reforms that would seem to be very much demanded is legislation that will prevent companies existing by authority of law from putting out debentures or scrip not represented by money actually paid into their treasuries, or by proprietory interests whose value is to be determined by disinterested parties. Pennsylvania has incorporated substantially such a provision into her Constitution. Her example should be followed by all other States.

For the losses they have sustained, investors, as a rule, have themselves chiefly to blame. The mistake made, in nine cases out of ten, has been the purchase of *cheap securities.* The hope of realizing a little more than ordinary interest, by buying paper at a discount, has proved to be the rock on which unnumbered capitalists have split. In addition to their money's worth, they have endeavored to get something for nothing, with the result, most generally, of getting nothing for something. It is remarkable how blind are people, ordinarily sagacious enough to make money, to the fact that property can not pay a revenue beyond its producing capacity. For instance, how can a railroad company, whose line is wholly or mainly built from the proceeds of mortgage bonds, sell them at a heavy discount, besides allowing large commissions for selling them, and then pay a high rate of interest on their face?

But for the losses referred to is there not too often somebody else to blame? The seller of investment securities is usually not the maker of them, but a professional middle-man known as a broker. The extent of his responsibility is a very interesting question. Is he justified in assuming that *caveat emptor* is the rule that is to govern; or is it incumbent upon him to inform himself as to the true character of the paper he offers, and give his customer the benefit of the knowledge he acquires? In other words, does he not, by virtue of the relation he bears to the purchaser, which is ordinarily one of confidence, become, morally at least, a sponsor for what he sells? In view of the millions of trash that have been unloaded upon the public as solid investments, of the true character of which it would not have been difficult for any one making a business of handling paper to inform himself, it is hard to reach any other conclusion than that there has been very great laxity on the part of many who, under the plausible titles of banker and broker, have made the selling of securities an occupation. It will hardly suffice for them to say in defense that they sold the paper at market prices. They should have known that the value of what they sold bore a reasonable approximation to the price that was paid. If they did not know it, and could not ascertain the fact, they had no business to dispose of the property. Manifestly, a higher standard in such matters should prevail, and the way to secure it is to hold those who professionally market investment securities to a far more rigid accountability than has heretofore been insisted on.

By what rule or rules is the investor now to govern himself? No formula can guarantee him absolute safety. One thing, however, he can properly count upon, viz., that he must expect to pay a fair price for a good security—one that will return him no more than a moderate interest on his money. If he wants to speculate, and is willing to take risks, that is another thing. He can then look for bargains. But there is such a thing as going too far in the matter of prudence. The investor may pay too dearly for safety. There are securities which, compared with others that are to be had, sell at prices much above their real value. The reason is that they are universally known to be good both as to principal and interest; but there are plenty of others, that may be had at lower figures, which are just as good. There is no reason in the world why the investor should not get at par all the paper he wants, that will yield him six per cent interest, and be as safe as any property can be under human supervision. In making the selection no more judgment is demanded than in purchasing lands and cattle. Two very common and often fatal mistakes should be avoided. One is in relying solely upon the advice of a broker. By far the greatest number of losses to investors has been in securities purchased exclusively on the recommendations of interested commission-men. While it is well to get the opinion of a reputable broker, the purchaser should investigate and decide for himself. The other is in giving a preference to "listed" securities. Many persons seem to think stocks and bonds must have a value if they are quoted at some stock exchange. On the contrary, such a position is likely to expose them to manipulation for purely speculative purposes. Stock-exchange quotations, as a rule, are unsafe guides to buyers. Every security must stand on its own merits, and purchasers have merely to follow business principles as taught by the canons of common sense.

CONCERNING CLOVER.

By GRANT ALLEN.

EVERY group of organisms, every genus and every species of plant or animal, has certain strong points which enable it to hold its own in the struggle for existence against its competitors of every kind. Most groups have also their weak points, which lay them open to attack or extinction at the hands of their various enemies. And these weak points are exactly the ones which give rise most of all to further modifications. A species may be regarded in its normal state as an equilibrium between structure and environing conditions. But the equilibrium is never quite complete; and the points of incompleteness are just those where natural selection has a fair chance of establishing still higher equilibrations. These are somewhat abstract statements in their naked form: let us see how far definiteness and concreteness can be given to them by applying them in detail to the case of a familiar group of agricultural plants—the clovers.

To most people clover is the name of a single thing, or, at most, of two things, purple clover and Dutch clover; but to the botanist it is the name of a vast group of little flowering plants, all closely resembling one another in their main essentials, yet all differing infinitely from one another in two or three strongly marked peculiarities of minor importance, which nevertheless give them great distinctness of habit and appearance. In England alone we have no less than twenty-one recognized species of clover, of which at least seventeen are really distinguished among themselves by true and unmistakable differences, though the other four appear to me to be mere botanist's species, of no genuine structural value. If we were to take in the whole world, instead of England alone, the number of clovers must be increased to several hundreds. The question for our present consideration, then, is twofold: first, what gives the clovers, as a class, their great success in the struggle for existence, as evidenced by their numerous species and individuals; and, secondly, what has caused them to break up into so large a number of closely allied but divergent groups, each possessing some special peculiarity of its own, which has insured for it an advantage in certain situations over all its nearest congeners?

Clover is, of course, by family, a pea-flower, one of the great group of the *Papilionaceæ*, a tribe of the vast leguminous race. Now, everybody knows the general appearance of the pea-blossom, a form of flower which reappears throughout the whole group, in such different plants as gorse, laburnum, peas, beans, vetches, wistaria, lupine, and acacia; and it is clearly this form of flower which gave the original ancestor of the papilionaceous plants its main advantage in the struggle for existence over almost all its compeers. In other respects, the various members of the pea-flower tribe differ widely from one another. Some of them are tall, woody trees, like the laburnum; some are bushy shrubs, like the broom; some are low, creeping herbs, like the clover; and some are lithe, trailing climbers, like the pea and the scarlet-runner. So again with their foliage: some have hard, spiky leaves, like furze; some have regular trefoils, like medic; some have long sprays of many leaflets, like the sainfoin; and some have clinging tendrils, like the peas and vetches. Once more, in the pod and seed there are infinite varieties of shape, size, and arrangement, as one may see by comparing peas with horse-beans, or the short, hairy pod of gorse with the long, smooth capsule of the vetch, the inflated globe of the bladder senna, and the twisted, snail-like spiral of the medic. In fact, there is hardly a single particular in which the papilionaceous plants do not differ from one another immensely, except only their peculiar flower. Clearly, then, it is the flower almost alone which has given them their fair start in the struggle for life. I say almost—not quite—alone, because, as we shall see hereafter, they owe much also to their relatively large and richly stored seeds. In this one point they early reached a state of equilibrium; in other points, they went on varying and adapting themselves to an infinite variety of external circumstances.

Though it is not my intention to deal at any length here with any of the papilionaceous tribe except the clovers, a few words must first be premised about this peculiar and successful type of flower. It consists, like most other blossoms of the dicotyledonous race, of five petals, inclosing ten stamens, and with a single ovary, or embryo pod, in its very center. But anybody who has ever looked at a pea-blossom knows very well that it is not regular and radially symmetrical like a dog-rose; it has its parts bilaterally arranged, so that an insect lighting upon the flower in search of honey necessarily brushes his breast against the stamens and pistil, and therefore cross-fertilizes the embryo pods by carrying pollen from one blossom to the sensitive surface of the next. The five petals have undergone special modification so as to suit this special mode of impregnation. The upper petal, known as the standard, is usually broad and expanded, serving as an advertisement to attract insects; and in many advanced species it is variegated with convergent lines of different colors, which guide the bee toward the exact spot where the nectaries are engaged in elaborating honey for his benefit. The two next in order, called the wings, are generally shorter and smaller, and in most advanced types they possess two little indentations, one on each side, specially adapted to afford a foothold for the legs of the visiting bee, in the exact position that will enable him at once to reach the honey and to brush off the pollen against the sensitive surface. The two lowest petals of all are usually united by their under edge, so as to form a single organ, known as the keel, and closely inclosing the stamens and pistil. As a rule, too, all ten stamens are united into a single tube or sheath; or else the nine lower ones are so united, while the upper one is free. In spite of the general uniformity of floral type, however, many special modes of insect fertilization prevail among the various pea-flowers. Sometimes the blossom bursts open elastically when the bee lights upon it, dusting him all over with the ripe pollen; sometimes a small quantity is pumped out from the sharpened point of the keel by the weight of the insect's body; sometimes the pollen is deposited from his breast on the spirally curled summit of the pistil; sometimes it is swept off by a little brush of hairs, situated close beside the sensitive surface of the embryo pod. All that it is here necessary to bear in mind, however, is the general fact that the papilionaceous type of flower has gained its present high position as a dominant floral pattern by its beautiful and varied adaptation to insect fertilization.

Such being the general nature of the pea-flowers as a whole, we have next to inquire what are the special peculiarities which have enabled the clovers in particular to fill their peculiar niche in the existing economy of Nature. Clearly, the positions which clovers are adapted to adorn are not the high places in the hierarchy of vegetal life. They are not tall forest-trees or bushy shrubs; they are not long, creeping trailers or climbers; they are herbs of low and procumbent character, best fitted for filling up the interspaces of taller vegetation, and for vying with the grasses as elements of the close, tender, delicate greensward. The points which have enabled them to survive, therefore, are just those which allow a plant to thrive under such special conditions; and we must ask briefly what those points may be before we proceed to consider the specific characteristics of the various individual clovers.

In foliage the clovers are distinguished by their graceful trefoil leaves which are an adaptation of the typical papilionaceous pattern to the special necessities of their humble situation. For the common form of pea-leaf consists of a long leaf-stalk, with one terminal leaflet, and with several pairs of lateral leaflets, arranged opposite each other along a central line. In the clovers, however, and in most other small field forms of papilionaceous plants, only one pair of lateral leaflets is developed; and this arrangement allows the leaf-stalk to be elevated among the surrounding grasses in such a way as to get freely at the sun and air, which are necessary for the nutrition of the plant. But the chief peculiarity of the clovers is the arrangement of their flowers in dense heads. Instead of the blossoms growing separately or in pairs, as with most peas and vetches, or in long, loose bunches, as with laburnum and sainfoin, the flowers of the clovers, much reduced in size, are crowded into compact little bundles, for the most part at the end of a long stalk. What we ordinarily call the flower of a purple clover is, in fact, such a head of clustered flowers. This dense clustering of the flowers makes them, though individually small, very conspicuous in the mass to bees and other insects, and so largely increases their chance of cross-fertilization. For the same purpose they usually secrete abundant honey, and they possess in many cases the familiar fragrant clover perfume. Moreover, in most though not in all species the bases of the five petals have grown together into a narrow tube, inclosing the honey; and in the common purple clover this tube is so deep that no British insect except the humble-bee has a proboscis long enough to reach the nectaries. Such peculiarities are quite sufficient to give the clovers an immense advantage in the struggle for existence; and it is not surprising that they should have become exceptionally numerous in species and individuals, even among the richly endowed and dominant papilionaceous family.

Every race, however, has its weak as well as its strong points; and the weak point of the highly successful clovers lies in the unprotected position of their seeds and pods. Hence, in accordance with the general principles above laid down, it is in these particulars that we might expect to find the various species differ most from one another, since this is just the part on which natural selection of favorable varieties is most likely to be exerted. As in the papilionaceous family as a whole, the flower is the organ which remains almost identical throughout, because it is the organ which gives the family its true importance; so in the restricted clover group the trefoil leaflets and the clustered heads of flowers remain almost identical throughout, and for the like reason. But in any classification of the various species of clover, it will be seen by anybody who looks into the matter that all the distinctive characters are drawn from differences in the pod and calyx after flowering, because this is the weak point of the genus, and the one in which alone diversities of habit have been likely to arise and to be perpetuated by survival of the fittest. The other organs have long since reached their equilibrium; these organs alone remain in need of further equilibration.

And why is the pod a weak point? For this reason. The seeds of clover, though small, are very richly stored with starches and other food-stuffs for the growth of the young plant. Such richness is, of course, in itself an advantage to the race, because it allows the seedlings to start well equipped on the path of life, with some accumulated capital handed on to them by the mother-plant. But what will feed a seedling will feed an animal as well; and it is just these rich little beans in the clover-pod which give it all its dangerous value as a fodder for cattle. Hence, in the wild state those clovers which have their seeds least protected are most likely to be eaten off and killed down by birds or animals, while those which have them most protected are most likely to survive and become the parents of future generations. Here, then, we have the basis upon which natural selection can act in differentiating the primitive ancestral clover into various divergent species. Whatever accidental variation happens to give any particular clover protection for its seeds in any special habitat will certainly be preserved and increased, while all opposite variations will be cut off and demolished at once. So far as their foliage and their flowers are concerned, the clovers as a body are practically in a state of stable equilibrium; so far as their fruit and seeds are concerned, they are still undergoing modification by natural selection.

Clearly to illustrate this fundamental point, let us first look at some neighboring and closely allied plants, which are not exactly clovers, but which resemble them in almost all important particulars. These also show the same devices for specially protecting their seeds and pods from birds or animals. Take, for example, the genus of the medics. These are mostly small greensward plants, with trefoil leaflets like the clovers, but with the flowers in rather tall, one-sided spikes or loose bunches. Their pods are usually long and many-seeded, but they have this curious peculiarity, that instead of growing straight like that of a pea or bean, they coil up spirally like a snail-shell. When ripe they fall off the plant entire, and thus defeat the hopes of birds and other creatures which wait patiently for the opening of the pods. The simpler medics, such as the agricultural lucern, have smooth, spiral pods alone, and therefore they can be employed successfully as fodder for cattle. But this, which proves an advantage from the point of view of the farmer, is naturally a disadvantage from the point of view of the plant in a wild state, because it insures the seeds being eaten; and hence the more developed and weedy medics have acquired stout protective prickles, fringing their globular spirals, and making them very distasteful morsels to cows or horses. We have two such prickly medics in England, one closely coiled and rolled round like a ball, and thickly set with curved hooks; the other loose like a corkscrew, with two rows of sharp bristles at the adjacent edges; and both these, as I learn from farmers, are extremely objectionable weeds in meadows, rendering the hay almost uneatable. Indeed, I am assured that cattle will never touch even fresh meadow-grass containing them except when absolutely driven by hunger. It is noteworthy that our two doubtfully native smooth medics (lucern and nonesuch) both grow naturally in rough, dry places, and are only largely found as "artificial grasses"—that is to say, were introduced and maintained by human agency; while our two more truly wild species are meadow and pasture weeds, and are therefore amply protected by prickles against herbivorous animals. Again, bird's-foot trefoil, whose pretty yellow flowers form such ornaments to our sunny banks in summer, has a long, hard, dry pod, too stringy to be edible, and filled with pith between the beans; while lady's-fingers, a somewhat similar type, has an inflated hairy calyx completely inclosing the short pod in its protective and inedible capsule. Strangest of all, however, is the small, matted bird's-foot, whose pod never opens to shed the seeds, but divides between them into little joints or "articles," each inclosing a single bean, and so cheating the expectant birds of their promised food. These examples, which might be multiplied indefinitely, will sufficiently serve to show the importance of protection for the seeds as a basis of differentiation among the papilionaceous flowers.

With the restricted tribe of clovers the need for such protection has almost alone produced all the species into which the genus has long since split up. Originally, of course, we must suppose that there existed one united type of ancestral clover, differing from the other papilionaceous plants in the points which now distinguish the whole clover genus, but possessing none of the special distinctive marks which specifically divide one kind of clover from another. This hypothetical ancestor had probably rather large, purplish flowers, collected in compact heads on a common foot-stalk, with the five petals separate, and with a small three or four-seeded pod completely inclosed within the faded brown petals. From some such form the existing clovers have sprung by differentiations almost entirely affecting the pods and seeds, though they have also varied a little in color, according to the individual tastes of their particular insect visitors, as well as in the degree of union effected between their petals. Without going beyond the limits of our own native clovers, we will look first at those types in which the arrangement of the pod is simplest, and then pass on gradually to those in which it is more and more complex, till we arrive at last at that most marvelous English species which actually buries its own pods entire in the ground by a wonderful series of apparently purposive movements and gyrations.

Our common English purple clover (for convenience' sake I adopt throughout Mr. Bentham's vernacular names) may be taken as a good specimen of the simpler and less-protected kinds. The mere fact that it is grown extensively for fodder shows that it has no deterrent prickles or bristles to ward off the attacks of herbivorous animals; and indeed, throughout the clover group, it may be noted that birds and insects, rather than large mammals, seem to be the enemies especially guarded against by the majority of plants. Purple clover is a perennial, with long, hairy stems, the hairs serving to prevent ants from creeping up to the blossoms and uselessly rifling the honey intended to attract the fertilizing bees. The young flower-heads are also inclosed in two papery wings or stipules, which effectually protect them from injury before they open. The petals are united into a very long tube, accessible only (as before noted) to the humble-bee; and in New Zealand, where our European humble-bee is unknown, it has been found necessary to import several nestfuls, in order to make the acclimatized clover set its seed for agricultural purposes. But the devices for the protection of the pod are here comparatively slight. Each pod contains, as a rule, only a single seed, and it is externally guarded simply by the wire-like calyx-teeth, which are long, thin, and awl-shaped, and fringed on either side by a row of thick-set hairs. The two lowest are longer than the others, apparently as a protection against crawling insects. After flowering, the petals remain upon the heads, turn brown, and inclose the ripening pod. These brown heads of overblown flowers have such a dead, withered appearance that they seem sufficiently to deceive all intending depredators. As a whole, the species seems to survive mainly because of its protected young flower-heads, its special attractions for fertilization, and its habit of inclosing the pods in the dry petal-tube. It should be noticed, however, that, though artificially propagated in meadows and pastures, it would not probably be a very successful plant if left entirely to its own devices. Man has intervened to give it his powerful aid by sowing its seed, and by fencing it off from cattle, so that it has now become, in spite of itself, one of our most abundant and ubiquitous clovers.

Next in order we may take a series of small, wild, purplish clovers, closely allied to this cultivated type, but more specially adapted for protection against animal foes. Of these the little knotted clover, which grows in our dry pastures and banks, is an excellent simple example. It is a small, tufted annual, often growing in very closely cropped, sheep-eaten crofts, and therefore with an acquired habit of creeping close to the ground, and spreading its foliage flat against the earth. Its calyx-teeth are short and almost prickly, and its little knotted heads grow so close in the angles of the leaves that even a sheep has hard work to bite them off with his nipping front teeth. The rough clover is another of these dwarf creepers, much like knotted clover in general appearance, but even more prostrate, and with its flower-heads still more closely wrapped up in the angles of the leaves, whose wings or stipules almost completely inclose them. The greatest difference, however, resides in the calyx, whose teeth here, after flowering, become broader and stiffer, curve backward, and give the whole plant a stringy, dry, innutritious look. This species or variety also grows mostly on sheep-bitten banks, and manages wonderfully to set its seed in spite of the manifold dangers to which it is exposed. Boccone's clover, confined in Britain to the Lizard Promontory in Cornwall, is a larger southern form of the same central type, closely allied to the knotted clover. It grows much taller, but has an equally forbidding type of pods; and I notice in Southern France, where it is very abundant, that the dry stalks and oblong heads of fruit are always left uncropped on bare banks and road-sides where goats and sheep have been browsing—a fact which clearly shows that even those omnivorous grazers consider it an unpalatable morsel.

To the same group, I think, but in a more developed degree, belong three or four other British species, whose protections are somewhat less easy to understand. Of these, clustered clover appears like a still higher type of rough clover. It is a slender, creeping annual, with very small, globular flower-heads, almost buried in the angles of the stem and leaves; and it has short, broad calyx-teeth, rigidly curved backward after flowering, and with hard, sharp points. This, I take it, is a protection against browsing animals. The sea clover, on the other hand, seems rather to guard against birds or insects. In the flowering state, it looks almost exactly like a small purple clover; but as the seeds ripen it assumes a very different aspect. First of all, the calyx-teeth grow out into rather broad green leaves, so that the whole head looks more like a mass of foliage than a bunch of ripening fruit. The lower tooth, especially, becomes very long and leaf-like; and it may be remarked that, as a rule, the two lower teeth in clovers differ more or less conspicuously from the upper ones, pointing apparently to some special danger of attack from below. As the pod slowly ripens, two lips grow out on either side of the calyx, and finally meet on the top of the pod, so as to hermetically seal it, leaving only a tightly closed aperture in the very middle. Thus the calyx has, as it were, a false bottom, appearing to be empty when it is not really so, and by this means deceiving would-be intruders. It must be noticed, however, that such a deceptive device would be useless against a herbivorous animal, which could crop off the entire head; it would only serve against birds or insects, which might pick out the seeds one by one. That it does effectually protect the tiny beans is certain, for in no case will you find a calyx without a pod inside it. At the same time, so thoroughly has the calyx with its outgrowth of lips usurped the place of the primitive pod-covering that the real pod is reduced to a mere papery envelope, and can only be detected as inclosing the seed by a somewhat careful dissection. In this sea clover, too, the entire head, when ripe and dry, has a very forbidding aspect, the mass looking decidedly prickly and stringy, like a teazle; and I observe that it generally remains uncropped until the calyx and seeds fall of themselves, especially in Southern Europe, where it grows very tall. Why it should be confined to the neighborhood of the sea and of a few tidal rivers, more especially to salt-marshes, it would be hard to say; probably the special danger against which it defends itself is one found only under these circumstances, in which case it would there alone have any advantage over its competitors. Indeed, it must not be supposed that all these questions are yet by any means finally solved. The sole object of the present paper is to point out the common principle running through the variations of the clover pattern, and to suggest such partial explanations of their causes as have yet occurred to a single observer.

Suffocated clover is another of the tiny creeping types, apparently protected for the most part against browsing quadrupeds. It is a wee tufted form, with minute flowers stuck close in small dense heads, as if gummed to the short stems, and very crowded along their course. We may regard it as the last effort of a very degraded race to keep up its existence in the most closely gnawed pastures, on sand or gravel, where only very dwarfed and scrubby plants can escape destruction. The reader will notice that under such circumstances two types of clover succeed, each in its own way. If the heads become very small, close, and inconspicuous, or tightly pressed against the wiry trailing stems, they escape the observation of browsing animals. If, on the other hand, though tall and noticeable, they develop prickly or stiffened teeth, they are rejected as unfit for food by the creatures which devour the surrounding herbage.

Reversed clover takes its name from a peculiarity which seems to be connected with its mode of fertilization, for it has its standard petal turned outward, instead of inward as in all other clovers. The meaning and object of this change I do not know; but its most marked feature is still one bearing upon preservation of the seed, for, after flowering, the upper part of the calyx becomes much inflated, and is traversed by large membranous veins. At the same time it arches over the lower half, leaving three small teeth below, and two swollen ones at the top, so as to form a sort of bladder-like capsule over the concealed pod. In this case, again, the protection is obviously designed against birds or insects. In the curious strawberry clover, common among dry meadows and road-sides in Southern Britain, the same device has been carried a step further. Each flower in the head is here surrounded by a long involucre of lobed bracts, and, after flowering, the calyx swells immensely, so as to transform the entire head into a compact globular ball of little bladders, each inclosing a single pod. This arrangement has been popularly compared to a strawberry, but it is much more like a raspberry, being a delicate pink in hue, and composed of twenty or thirty small round capsules. The upper half of the bladder is likewise thickly covered with fine down, doubtless very objectionable to the skin of the tongue, and the whole is netted and veined in the most delicate and beautiful fashion. Hardly any other clover possesses so advanced a plan for protecting its little pod.

Another type is presented to us by the large crimson clover, not truly indigenous in Britain, but commonly cultivated for fodder in the south of England. It is a soft, hairy plant, and, like other fodder-clovers, it does not possess any very advanced protective device. Still, even here, the calyx has extremely long, narrow teeth, thickly covered with smooth hairs, which serve to keep its beans safe. The analogy of a prickly pear or a rose-hip will show how very unpleasant such hairs feel in the mouth. The beautiful, small harefoot clover derives its expressive name from a further development of the same principle. The long teeth of the calyx project beyond the flowers, and are enveloped in soft, downy hair, which gives the whole head a very dainty, feathery appearance. As soon as the flowers are faded, the head looks like a mere mass of soft fluff, unenticing to herbivorous animals, and effectually concealing the seeds from birds or insects. The starry clover of Southern Europe, naturalized in England at Shoreham and a few other spots, starts from much the same point, but has specialized itself both against large and small depredators. On the one hand, its smooth, woolly calyx, much like that of crimson clover during the flowering stage, spreads out after blossoming into a star-shaped pattern, and forms with its neighbors a dry, bristly, interlacing head, thickly studded with sharp hairs; and this suffices to protect it from cattle and goats. On the other hand, the mouth of the calyx, being thus exposed by the spreading of the teeth, is closed by a perfect *cheval-de-frise* of convergent tufted hairs, all meeting in the center of the throat; and this barrier answers the same purpose as that of the sea clover, though in a different manner, by forming a false bottom to exclude insects. I notice on the dry Mediterranean hills that these bristly heads are rejected by the goats and sheep, like those of Boccone's clover, and even donkeys refuse to eat them.

Turning to a somewhat different class, there are some clovers which protect their seeds in a quite distinct manner, by merely turning them out of sight. Common Dutch clover does this in a simple yet very noticeable fashion. It bears its pretty white flowers in tall globular heads on a lengthened footstalk, which renders them extremely conspicuous objects to the fertilizing bees. But each flower is stalked within the head, and, as soon as it has been fertilized, it turns downward, and fades brown against the common footstalk. Every head of Dutch clover thus habitually consists of two parts—an upper part, containing erect open flowers or flower-buds, not yet fertilized; and a lower part, containing overblown flowers, already fertilized, and now engaged in setting their seed. This plan combines two distinct advantages at once. In the first place, the bees lose no time in discriminating between the mature honey-bearing blossoms and those already rifled, which insures more frequent visits and a larger general average of seed-setting. In the second place, the fruiting pedicels and pods, being turned down and concealed, are less likely to be visited by small animal foes, such as flying insects, which might lay their eggs within, and let the grub feed (as often happens) on the growing seed. Dutch clover is a fodder-plant, and therefore, probably, in its native state does not grow much in places exposed to the ravages of large herbivores. At the same time, the pod is many-seeded, and the plant spreads largely as well by creeping and rooting at the joints.

That the object of the turning down after flowering is distinctly to protect the pod, as well as to save time for the bees, may be seen, I think, from the analogous instance of the pretty little yellow hop clover. This common and graceful English plant has primrose-colored flowers, and (as usual with yellow blossoms) depends mainly for fertilization upon a smaller class of insects than Dutch or purple clover. But after the blossoms are fertilized, they turn down in the same manner as in Dutch clover, only far more markedly, giving the head a considerable resemblance to the hop-cones from which the species takes its name. After being thus reflexed, the faded but persistent petals close over the pod, and the standard becomes furrowed with deep marks, which seem to me intended to give a crumpled, withered appearance to the head. Simple as is this device, it nevertheless effectually conceals the pod within a closely imbricated set of scales or shields, each one folding over the next like tiles on a house, and entirely preventing the access of birds or insects to the seeds. The lesser clover and slender clover seem to me to be successively dwarfed and degraded states of the same plant, due apparently in part to bad soil, and in part to diminished need for special protection.

Last of all we come to the most advanced and developed type of any, the subterranean clover. In general appearance this plant closely resembles Dutch clover, from which, in all probability, it is a remote descendant. But, growing, as a rule, on dry, sandy, or gravelly pastures closely nipped by sheep or other herbivores, it has acquired a very remarkable and ingenious mode of escaping their depredations. Like the other species similarly circumstanced, it grows close to the ground, in small tufts ; and it bears a few rather large white flowers, two or three together in a starved-looking head. Looked at closely in this stage, a number of small central knobs may be distinguished at the end of the common flower-stalk. These knobs are really the calyxes of undeveloped blossoms, completing the head. After flowering, the stalks lengthen and bend down to the ground, carrying the fertilized pods with them. Then the minor pod-stalks bend back, and the undeveloped central flowers grow out into short, thick awls or gimlets, with five finger-like lobes at their extremity, representing the five spreading teeth of the original calyx. These awls next begin digging their way into the earth by a slow, gyrating motion, and at last wear out a hole in which they bury the pod and bean entire. Thus the plant actually sows and manures its own seed, and so escapes all danger from the grazing animals. This extraordinary action may be considered as the high-water mark of ingenuity and foresight in the unconscious outcomes of natural selection among the clover kind.

In conclusion, it may be added that many of these clovers are very difficult to discriminate from one another in the flowering stage ; it is only when the fruit begins to ripen and the calyx to assume its characteristic shape, that they can be readily identified by safe specific marks. Throughout, in short, all the clover traits remain almost the same, except in the matter of the fruiting pods. This is the one weak point of the genus, and this is therefore the place where natural selection has been able to produce fresh differentiating effects. Such a brief consideration of one small group of plants may serve to bring the general principle with which we started into the definite relief of concrete application; and it may also serve to show the vast variety of detail with which Nature effects the self-same object, even within the narrow limits of a single family or genus.—*Gentleman's Magazine.*

THE PROBLEM OF HIGHER EDUCATION.

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FEW subjects have of late engaged the attention of the most thoughtful people of this country in a higher degree than the question prominently brought before the public by the recent attempt of the Harvard faculty to open the doors of that famous institution to applicants who might come prepared in all the branches hitherto required for admission, except Greek, for which study they would have had to offer an equivalent in scientific and mathematical work. It has been generally admitted that this work would have been more severe than that required for the Greek, but the opponents of the measure have, nevertheless, assured the public that to omit the Greek would be detrimental to American scholarship, and equivalent to building the educational structure on an unstable foundation. Some of these opponents have gone so far as to assert that the customary college degree, Bachelor of Arts, stands as definitely for Latin and Greek as the degree M. D. stands for the study of medicine. Now, inasmuch as the college is the school in which, according to the best authorities, our young people are expected to gain a higher degree of education than the lower schools, academies, and high-schools can give them, the question, What constitutes the basis of higher education? is answered by the opponents of the Harvard measure in favor of the traditional Latin and Greek course, and that only. But the very fact that men of such high standing in the domain of education as President Eliot and his associates hold a different view should be sufficient to entitle this view to respectful attention. It is, of course, easier to fall back on well-known authorities, and the usage of the past, than to examine carefully into a subject that evidently has at least two very characteristic sides; but if the subject is one that so greatly affects the rising generation, it may be expected to prove of interest at least to those who, as parents, desire for their children such an education as will make them efficient and happy members of the nation into which they were born. The highest possible intellectual efficiency and individual happiness, based on a harmonious development of the various faculties of mind and body, are the two principal aims of all education. There is a strong and intelligent party who sincerely believe that these aims are best attained by the college training such as it has been, and who, therefore, wish that this training shall continue for all time. There is another party, not a whit less intelligent, and probably far more numerous, who maintain that the highest and best education is not necessarily of one type; that it may differ as individuals differ; that the college itself has changed in the past, is changing now, and is quite certain to change in the future in accordance with a well-known law of human life, and that, therefore, it is neither logical nor fair to require every young person of the present time to follow the example of older persons, in the kind and manner of education which passed as the best when these older persons were young. This party further insist on its being unfair to shut the doors of the only schools in which, according to the view of their opponents themselves, the best education should be given, against those who honestly entertain different views of education, and they ask: Why should you who control these schools deny to us and our children a right which we, on our part, are willing to grant to you? Who is to be the judge between us? Is the college to be forever the school only of one set of believers?

Questions like these, coming as they do from people who are neither superficial nor ultra-radical, can not be turned off by generalities and commonplaces. To argue as though Greek and thoroughness are convertible terms is begging the question. No one denies that Greek studies may be thorough, and that those who are engaged in them may, if they choose, regard them as superior to any other. It is only when they wish to force their own conviction on those who differ with them that their claims will meet with opposition. There is a superstitious belief in the efficacy and superiority of Greek that makes one think of the fabled tanner, who, when asked what material he considered best for fortifying a city, unhesitatingly answered: "Leather! there is nothing like leather!" Arguments of this kind are difficult to answer, mainly for the reason that one can not and will not deny that leather is a superior article. There is much that can be said in favor of the study of Greek, and if it could be shown that it is necessarily the business of the college to teach Latin and Greek as specialties, in the same sense that medical schools teach medicine, nothing would be more absurd than a course of college education with one of these languages entirely omitted.

It can not be denied that for a long time the idea of college education necessarily presupposed a knowledge of Latin, Greek, and even Hebrew, because these languages were the keys to the knowledge the student desired to obtain. But this had not always been so. At first Latin alone was used. The introduction of Greek often met with intense opposition, for instance, at Oxford. Greek stood then for new ideas, it was the treasure-house of the most valuable knowledge, and the professors of the old school thought then, as some of their colleagues seem to think even now, that the old education had been good enough for them, and therefore must be the best for every one else. But the rising tide of the Reformation soon settled the question of Greek. The demands of the times were of a religious nature, and the New Testament was written in Greek. And, besides, whatever there was to be found out about science, political, mental, and even physical, had to be searched for in Greek books. To be ignorant of Greek was then as serious a drawback for a scholar as to be ignorant of German and French is to-day. Latin was the native language, so to speak, of every scholar. It was the common medium of social and learned intercourse; the speech in which the professor lectured and the student answered when examined; the language used in public disputations, on the rostrum, in the courts, and even in the theatre.

There were, of course, also the specialties of Latin and Greek grammar and literature, as there are the specialties of English grammar and literature in our colleges, but the general purpose and aim of the college was to impart knowledge of facts, or what was taken for facts, in matters historical, physical, philosophical, theological, and, naturally enough, also philological and literary.

In the discussion of this subject frequent reference has been made to the higher schools of Germany. Now, it is a fact that the German universities have continued the idea of the old university more faithfully than any others. The most successful old university, that of Paris, had contained the four faculties of theology, law, medicine, and the "arts." The terms of admission, as far as scholarship is concerned, are the same for all. They are still the same for all in the modern German university, with one notable exception, of which we will speak further on. The American college ought to correspond to the faculty "of arts"; it may at least be compared to it, though, as a matter of fact, the preparation for the German school is more severe and extensive than the preparation for the American college. As the latter gives to its successful graduates the degree of bachelor "of arts," the former used to confer on all who passed the proper examination the degree of master "of arts." What were these "arts" originally? They are enumerated in the following line: "Lingua, tropus, ratio, numerus, tenor, angulus, astra"—i. e., grammar, rhetoric, dialectics, arithmetic, music, geometry, astronomy.*

That is, the degree "of arts" meant proficiency in these branches,

* Raumer, "Geschichte der deutschen Universitäten."

and it was merely an historical accident that these branches were taught in Latin, and, to a large extent, learned from Greek text-books. The same was true of the other faculties. It would be just as logical to demand that our candidates for the degree "M. D." shall be examined in Latin on the contents of Greek texts on medicine as it is to say that the degree of Bachelor or Master "of Arts" stands for the languages in which the studies were taught and studied, instead of standing for the subjects themselves.

At the German universities the teaching was done in Latin as late as the beginning of the eighteenth century, and, in one or two branches, through the entire century, and, in one or two instances, even into part of the nineteenth. It was then a necessity for the higher school to require of its students familiarity with this language, and it was the special business of the preparatory schools to give them this familiarity. This is the original and true reason why Latin even now occupies such a large place in German secondary instruction. It is the force of tradition, to which has since been added the conviction that the study is the best possible for all on account of its intrinsic value. This, however, was an after-thought of those whose business it was to teach it, and the same is true of Greek. The example of Latin naturally suggested the same reasoning for the study of Greek, and the preparatory school did what it could to send to the university students who should be able to use both these languages in actual study, and for the purpose of gaining information from books printed in them. But gradually and steadily the subjects taught at the university took a wider range. What had been the very best preparation for the few subjects originally taught at the university became soon of special value only for a few subjects. The preparatory schools were called on to meet the increasing demand. They had to add many other branches, French among them, to their course, and thus it happened that the German student who wished to prepare for the university had to spend from eight to ten years in studies that required his presence at the school for thirty-two hours per week, about one half of which was devoted to the two specialties, Latin and Greek. We say "specialties," for such they were, and still are, although the strange claim is made that this preparatory school, the "gymnasium," does not intend to teach specialties, but tries to guard against the danger of the one-sidedness of special pursuits by the introduction of the two ancient languages. Those who make this claim fail to see that, were it not for the sixteen or seventeen hours of other instruction that the school now imparts, the German student would still be the same unpracticable pedant, distinguished only for his absolutely dead learning, and all but total ignorance of everything else, that he was a hundred years ago. It is only in a comparatively small part that the occupation with Latin and Greek liberalized his intellect and opened to him visions of intellectual growth. To a far greater extent this was due to the attention he began to give to his mother-tongue and to the great authors of his own and of neighboring lands. Plato and Aristotle, Cicero and Horace, did something for him; but what was that compared to the intellectual wealth of the new world of science and the vivid inspiration that came to him from the pages of modern thought? To deny this is to refuse to see the light of the noonday sun. Poets like Dante, Shakespeare, Molière, Schiller, Goethe, took a powerful hold of his imagination, refined his moral nature as no ancient poet could, and filled his soul with ideals of the modern world. Voltaire and Hume, Rousseau and Diderot, Carlyle and Kant, Herder and Lessing, taught him how to reason, and to deal with the problems of modern life. And to-day can it be truly said that the inspiration the German student draws from Plato and Aristotle can be compared to the powerful impulse and the incomparable intellectual help he receives from contemporary writers like Humboldt, Ritter, Peschel, Schleiden, Haeckel, and a host of others in various fields of science and philosophy in his own land, and, among neighboring nations, from the pages of a Charles Darwin, a Huxley, Tyndall, Claude Bernard, and entire galaxies of others?

We may repeat, therefore, that the German gymnasium teaches Latin and Greek as specialties, and that if this special training has not shown in its students the bad effects that are usually attributed to such training, the merit of having prevented these effects lies with those other studies which, as we have seen, occupy the student for the other half of his time. If, now, we compare the courses of the corresponding American schools with those of the Prussian (or German) gymnasium, we find that, while the American school has the same studies, it does not succeed in doing the same work. Hence, in order to make up for the deficiency of time, the preparatory training is continued in the college proper. But if the object were to give the American student as thorough a training in the Greek and Latin, without neglecting the other studies taught in the German gymnasium, the entire time of the college would be taken up by these so-called preparatory studies, so that the college would have no time, or but very little, left for other work. This is a very serious objection to the adoption of the German system, and the only alternative would be to establish our preparatory schools exactly on the same basis as the German gymnasium. But would this be desirable, even if it were feasible?

Unquestionably the habit of constant application for so many years, during which his study-hours are twice as numerous as those of his American colleague, while his vacations are briefer and his days of recreation fewer, makes the German student unusually capable to profit by further instruction after having passed through the gymnasium. He is very accurate in some knowledge, and perhaps the very fact that he has specially emphasized a few branches so that now he knows at least something very well, gives him an advantage over other students who know something of many things without being perfectly at home in any. At the same time he will be found to have suffered in health. Very likely his eye-sight has been injured. As a rule, he is deficient in vitality. Fortunately for him, the university system is extremely lax. At the university he can do pretty much as he likes. He makes up for the time lost, sometimes in such a manner as to procure him from the authorities the *consilium abeundi*, the invitation to pursue his studies at some other institution. Then comes his year of military service, during which he passes the greater part of the day in admirable out-door exercise. It has been frequently remarked by educated Germans, and especially Prussians, that this year of military duty is the salvation of the manhood of the nation, at least for that portion of the young men that spent the best years of their youth in the close confinement of the learned schools.

Let those who insist so strongly on the necessity of imitating the German usage carefully reflect on this side of the question. But there is still another side. We have all along spoken of the Latin and Greek preparation as though it were absolutely true that the students who arrived at the university from the gymnasium have actually mastered these languages to which they have sacrificed so much of their time. They are expected to read Greek books understandingly. The medical faculty of Berlin expressly stated it as one reason why those who wish to enter the university should know Greek, that they must be able to read Galen in the original. If such a proficiency in Greek is expected of them in the department of medicine, it is, of course, also considered necessary in the department "of arts," and so in the other two departments of the university.

The facts tell a different story. Numerous proofs could be furnished to show how little even the gymnasium succeeds in making its students get such a hold of two ancient languages as will make it all but impossible for them to lose the knowledge so gained before they are through their university course. We will confine ourselves to the testimony of one of the most competent scholars of Germany, the late Eduard Lasker, who recently died in this country while on a visit, and who is considered by Julius Rodenburg, the distinguished author, and editor of the "Deutsche Rundschau," as no less pre-eminent a philologist in the domain of Latin and Greek studies in Germany than Gladstone is reputed to be in Great Britain.

According to Mr. Lasker's most positive experience, it is impossible for the gymnasium to keep up the teaching of the two ancient languages, because, in attempting to teach both, they succeed in giving the student a good knowledge of neither. He recommended that the attention now divided between the two be concentrated on the Latin alone, as there was, of course, no use trying to curtail the other branches. This view of so distinguished a scholar and thinker is of very great importance. It proves at least this, that there are in Germany men of acknowledged ability, undoubted honesty, and sincere love of education, and able to judge of the system from personal experience, who desire such a change in the preparatory schooling as would permit a student to go to the university without having studied Greek at all. Is it a sign of a shallow mind to discountenance in America, under circumstances that make the experiment far less likely to succeed, what is thus proved to be partially a failure even in Germany? Is it true that those who hold such views are justly chargeable with a wanton desire to destroy a well-tried system of "thorough" education, in order to introduce new-fangled notions of their own?

But the gymnasium is not the only school that prepares for the university. At present another school in which less Latin and no Greek are taught, called "Realschule," has also the right to give its graduates a certificate of "maturity" which entitles them to membership in the university, at least in some of the courses of the "Arts" department. This fact should, therefore, be borne in mind: that the German universities *do* admit students who, instead of Greek, offer other studies, very much as Harvard would have done if the proposition of its faculty had not been overruled by the superior board. The professors of the German universities mostly favor the "gymnasium," from which almost every one of them was graduated, but they are not so unreasonable as to set up their own individual preferences against the intelligent views of a considerable number of highly educated people who are not professors. Hence, whatever the example of German universities may teach us, the lesson of intolerance is not taught by it; at least not of intolerance in the sense that the views of an intelligent minority must be absolutely disregarded by the majority.

The German "Realschule" teaches science and mathematics, Latin, French, English in connection with the other branches, German language and literature, etc., common also to the gymnasium. It is claimed that this course is not so beneficial to the student as that of the gymnasium, and a ten years' trial of the Berlin philosophical faculty seems to have proved this. We will not here enter upon a discussion as to the probable causes of this failure of the Realschule beyond stating the well-known fact that hitherto the Realschule has not been generally patronized by those who aspired to the higher education of the university. The prejudice in favor of the old, well-tried, and splendidly equipped gymnasium was so great that this school naturally attracted the majority of those who wished to go to the university later. The course of the Realschule (i. e., that of the first order or class, there being also a lower order or class) is just as long as that of the gymnasium, but the graduates of the Realschule are few in number, and it is the exception, and not the rule, when one of them finally attends the university. Hence it is manifestly unfair to base a definite opinion of the possibilities of this school on the work hitherto done under circumstances so very discouraging. Even now the gymnasium is favored with privileges which are as yet denied to the Realschule, as no graduate of the latter is admitted to the departments of law and medicine, at least not in Prussia. That the comparatively few graduates of the Realschule have, nevertheless, made a fine and honorable record for themselves is an undeniable fact. It is unnecessary, however, to enter into a defense of that school, as it has not been in existence long enough, at least as a school that aimed to prepare for the university, to show what it will be able to do when once the prejudices now raised against it shall have disappeared.

The German university requires of its candidates for the degree of M. D. such a familiarity with Greek as will enable the students to read Galen in the original; but do the medical students really consult Galen in the original, either at the university or in after-life? I have been at the pains to gain some proofs of this laudable practice, but thus far in vain. The all but unanimous testimony is that the medical student's greatest desire, next to knowing the practical details of his profession, is to be able to read the works of the best English and French authorities, and especially the periodicals that bear on medical and kindred subjects. But English is not, as a rule, taught in the university, nor is it one of the required studies of the gymnasium, and the immense amount of labor the student has to perform makes it impossible for him to do enough for the study by private effort. And, then, the prejudice against so "easy" a language! This prejudice, the result of the peculiar training of the college, is one that college-men entertain like a dogma, and which they never tire of impressing on the student.* The acutest critic of France, Sainte-Beuve, incidentally alluded to this prejudice in his defense of Racine's masterpiece, "Athalie." He said: "Great lovers and judges of antiquity, *but who are not, perhaps, as great judges of the French beauties of 'Athalie,'* maintain that Sophocles (in his 'Antigone') is superior. . . . I listen, and let them talk (*J'écoute, et je laisse dire*). *I envy those who are possibly capable of judging with equal correctness* (*au même degré*) *of the two kinds of beauties*," etc. The modesty of the remark, coming from one who was himself no mean judge of antiquity, ought to inspire other critics with a reasonable diffidence when about to pass judgment on the difficulties of other languages. One may learn a dozen languages moderately well in less time than it takes to learn a single one well.

On the Continent of Europe one may meet with many illustrations

* If the difficulties of a language are its chief recommendations as a study for "discipline," the introduction of improved methods of teaching, by enabling the student to master these difficulties by an "easy grade," would in so far destroy their value. For a curious illustration of this prejudice, see a recent article on "Ancient Languages" in the "Bibliotheca Sacra."

of this fact. The "Cologne Gazette," for instance, used to publish the periodical advertisement of a German who undoubtedly prided himself on his English. Desiring to obtain some English boarders, he wound up with this remark, "The diet is notorious and unlimited." What he really meant was that he set a good table, and there was plenty to eat. It is this kind of modern language which some writers evidently mean when they speak of the facility with which translations from modern languages can be made. Let us suppose there were no prejudice against the modern languages, and none in favor of Greek, what would happen? The medical faculties would, no doubt, advise their students to avail themselves of every opportunity to obtain a good knowledge of the three languages in which the chief results of modern civilization are recorded. But to do this with a reasonable chance of success, such students must be allowed the necessary time. They can not find this time for the modern languages as long as the college compels them to devote it to the ancient. To measure fairly the disciplinary value of such a language as English is not an easy matter. Take, for instance, the choice of synonyms. Soup and broth seem to mean the same thing, at least in poetry, and yet the poet may want to use the one in a place where he could not use the other. An English gentleman spent an evening in Venice at the theatre. The piece represented was an Italian version of "Macbeth." In the course of the play our Englishman heard the expression, "Polenta infernale," which he mentally translated into "infernal soup," without being able to recall the original passage. Having returned to the hotel, his first care was to examine the English work, when he was delighted to find that the immortal bard, far from using the shocking "infernal soup," mentioned only the comparatively harmless "hell-broth."

Whoever has consulted a dictionary of synonyms in the English, German, or French language, will receive with some doubt the assertion that the ancient languages are richer in this respect than the modern. The celebrated historian, Guizot, devoted many years to a dictionary of French synonyms, which contains over eight hundred pages. The astonishing wealth of the German vocabulary is well known, and the philosophical spirit of the nation has introduced such a great number of the nicest shades of expression that a translation from the German, in order to be good, requires an extraordinary effort.

"*Traduttore traditore*," say the Italians. "A translator, a traitor." Not necessarily. There are translations and translations, but, after all, to translate fluently from one language into another is not the real object of language-study. Unless a student reads a foreign language as he does his own, he has not mastered it, but to gain this ability is a far more serious undertaking than is commonly believed.

Be this as it may, it is at least certain that a doctor of medicine, or a candidate for the degree, should have an ordinary knowledge of botany, at least of so much of it as will enable him to recognize camomile when he sees it, and to tell the difference between hemlock and parsley. Now, this remarkable charge is laid against many of the candidates for this degree in Germany, that they have not obtained this knowledge.* They may be able to read a quotation of Galen in Greek (although they would understand it infinitely better in the elegant German version they have in their library), but as for camomile and hemlock !—pshaw ! That is the apothecary's business.

Without wishing to sit in judgment over such facts and views, this, at least, we may do : we may affirm that there are many persons, who are neither shallow nor uneducated, who yet prefer in their physician a thorough knowledge of botany to any degree of skill in reading Galen in Greek.

The American college crowns the educational structure of the state. To increase its power for good, it ought to be accessible to any student who has passed through the preliminary training of the common, grammar, and high schools. It is not at all true that those who oppose the present college preparation desire to make education less efficient ; rather ought it to be said that many intelligent friends of education wish to make a more efficient collegiate education available for a larger number. The college should not be a school for one specialty, but rather a school in which many specialties are taught by the very best specialists. In such a school ancient languages and literatures would hold a place alongside of modern languages and literatures ; the sciences of astronomy and physics would stand on the same level as the sciences of botany and geology ; moral and mental, political and social science would be equally well represented. There is no reason to fear that ancient learning would suffer, but some to hope that it would be carried on by those who are drawn to it by natural taste and ability, and not simply because it is the fashion. What can be more unpractical to the common mind than the study of the stars ? What immediate profit does "star-gazing" hold out ? And yet Nature produces the requisite number of born astronomers, who, at one time or another, recognize their vocation, and reach it with the directness of the ball shot from a well-aimed rifle. The essential thing is, that the young student must not be allowed too soon to make his choice of studies. For this reason a preparatory course, which may extend through the first two years of college, seems to be a necessity. There is nothing to prevent an American college from allowing this preparatory course to be of such a nature as will enable the student to elect between two studies of similar value. This limited election would still be of the nature of a prescribed course. It would be very nearly what the Harvard faculty have tried to introduce. It will remain an open question for a long time to come, what study should be offset against the Greek,

* Report of the Prussian Minister of Education, July 11, 1868. "Paedagogisches Archiv" (Langbein), 1872, pp. 22, 23.

if once the principle should be recognized. But this would be a matter of detail, which the different faculties would eventually settle, and there is no reason to fear that any faculty would long continue an elective system which experience should prove to disqualify students from choosing their subsequent studies intelligently.

What is needed, first of all, is the frank acknowledgment on the part of those who now control our colleges that these institutions are intended to furnish the means of higher education for all who are by nature fitted for it, and that, as long as there are divergent views held by men equally eminent, as to the proper preparation for the higher college studies, it behooves no one, who happens to be in power, to use his authority for the purpose of monopolizing the college for the application of his own theories. It is not from a wish to lessen Latin and Greek learning that the plea is made to treat other studies with equal liberality. There is no onslaught made on Latin and Greek, but, on the contrary, those who favor the monopoly of Latin and Greek are often guilty of making an unwarrantable onslaught on modern studies. The tendency of our colleges, in spite of the conservative element in them, is toward the breaking down of this monopoly. The increase of elective courses in all the prominent colleges is a most significant sign.

ORIGIN OF COLOR IN ANIMALS.

By M. PAUL MARCHAL.

OF all the characteristics of organized bodies, color is one of the most fugitive. Trifling variations in the individual constitution, apparently slight changes in the biological conditions to which it is subject, are often sufficient to induce considerable modifications in the exterior coloration. Color in animals may, therefore, be regarded as having a variety of origins. Sometimes it is due to the fact that the tissues are formed from colored material; more frequently to their having imbibed a colored fluid. This is generally the case with the formations of the epidermis, the hairs of animals, the feathers of birds, and the scales of reptiles. The translucid nature of the teguments may also be the cause of external coloration, as in men of the white race, whose delicate skin exhibits the vessels of the underlying tissues. Many invertebrates are so transparent that their internal organs may be seen. In the majority of cases, animals owe their external hues to colored granulations or pigments, which, diffused through the tissues, give tints varying with their abundance or distribution. This substance may be black, or brown, or yellow in the vertebrates, while red, yellow, blue, and green predominate among the invertebrates. The phenomena of interference presented by their laminæ, dependent upon the reciprocal action of parallel waves of light of different velocities, and capable in their different combinations of producing all the colors of the rainbow, or the absence of color, furnish that dazzling chromatic gamut which Nature employs to paint the humming-bird and the butterfly, those two jewels of the organic world. Another class of phenomena has been called cerulescence by M. G. Pouchet. It is a property which he regards as analogous to fluorescence, and as due, in the majority of cases, to stick-shaped bodies inclosed in special cells called *iridocytes*. The blue reflections presented by the scales of most fishes, the blue color of the caruncles of many birds, and the naked parts of some monkeys, the azure tint of the veins of individuals of the white race, the blue of the iris of some persons' eyes, are examples of cerulescence. These phenomena, however, differ but little from those which give to water having drops of milk suspended in it a bluish color by reflection, or from those which make smoke appear blue when seen upon a black ground. It seems to me that it may be going too far to compare such phenomena with fluorescence.

These causes of coloration may be superposed and combined in a thousand ways. When birds are under the influence of physiological excitations like those of rage or love, the flow of blood contributes to enliven the color of the bare parts to the point of greatly modifying it. The bright, metallic tints of the peacock and the humming-bird are due to phenomena of interference and to the presence of a dark pigment combined; the green tint of the lizard to the association of a yellow pigment and blue-reflecting iridocytes. The Annelids and the Nemertes, of the invertebrates, exhibit the combined effects of three causes of coloration: iridization, produced by the thin cuticle; the rich pigmentation of the dermis, and frequently, also, in case the integuments are transparent, the variable coloration of the sanguineous fluid and of the internal organs.

The intensity of coloration is generally proportioned to the vital activity. As life begins to decline, the pigment retires from the formations of the epidermis; and the hairs on regions which have passed maturity often exhibit a lighter coloring than on the neighboring regions. According to Pruner-Bey, the intensity of the color of the negro is an indication of his health; old negroes grow pale as they age. It is well known that pain and depressing moral trials, which are negative facts in life, provoke the retraction of the pigment. On the contrary, everything that tends to accentuate life occasions an enlivening of the intensity of colors, a fact of which Darwin gives many examples in his "Variation of Animals and Plants." Coloration is strongest in adult animals. Breeders prefer animals rich in pigment-matter, because they will best resist disease, and most easily accommodate themselves to special systems of feeding. The ancients regarded animals having white hair on a black skin as the most vigorous. White parts of animals are often attacked with disease, while the other parts remain healthy; and light-skinned animals are most troubled by flies and parasites. Albinoism, which is simply a total inaptitude for the production of pigment, is a sure sign of degeneracy.

Vigor of the genital organs is one of the most manifest signs of vital activity. The relation between the reproductive function and pigmentation is so striking that Heusinger has expressed it as a law. Troubles brought upon the sexual functions under the influence of any particular causes, as of domestication, often coincide with the most singular modifications of color.

The coloring-matter is also intimately connected with the nervous system. Thus, it is at the extremity of a nerve, the optic nerve, that is localized, in all species of animals, the maximum of aptitude for the production of pigment. In the lowest types of the series, when the eye begins to become differentiated, and while it can hardly yet be considered an organ of vision, a pigment-spot may be observed to make its appearance. At the same time other parts of the optical apparatus that have a much greater functional importance, the refracting media, for example, may not yet be existing even in a rudimentary state. These considerations lead me to believe that the optical pigment-spot owes its existence not solely to the advantages which the individual may derive from it, but chiefly to the proximity of a nerve, the elements of which are disturbed by a continuous vibrating movement, or by light. This kind of election of pigment exists, moreover, not only in reference to the organ of sight, but frequently also in other special sensitive terminations—at the ends of the auditory nerves with some invertebrates, at the end of the proboscis in the Nemertes. In the chameleon, the turbot, the cuttle-fish, and some other animals, the connection of the pigmentary system with the nerves is so close that a simple nervous excitation is enough to modify the distribution of the colored granulations in the integuments.

On the other hand, certain constitutional defects induce a diminution or absence of coloring-matter, of which I can give no better illustration than to cite Darwin's curious observation that white cats generally have blue eyes and are deaf.

What we have said tends to prove that the positive facts of life, or the complete development of the organs of the individual—health, strength, fullness of functions, display of activity and accentuation of animal vigor in the nervous system and the organs of relation—correspond closely with an abundant production of coloring-matter; while the negative facts of life—age, constitutional weakness, disease, apathy, and degeneration generally—lead to a more or less complete disappearance of the same substance. Nevertheless, we notice in some cases the contrary fact, or a deposition of coloring-matter, or an increase of its production in connection with some pathological condition of the organism. But these cases, which seem opposed to our theory, are generally susceptible of special explanations, and their contradiction of the other facts is only apparent.

In consideration of the influence of external agencies on coloration, we distinguish between two classes: those forces which can be resolved into a rapid vibration—light, heat, and electricity—the action of which is very marked; and other more complex agencies, among which we include food, captivity, moisture, and the colorizing and decolorizing action of some secretions. Light is the principal excitant capable of provoking the development of coloring-matter. Very significant on this point is M. Paul Bert's account of his experiments with the larvæ of the axolotl: "Pale on issuing from the egg, they become colored by the deposition of pigment under the influence of light. In the dark, or in red light, the pigment is not developed." From this we learn that the less refrangible rays have no influence on the production of pigment; it is therefore by the rapidity, and not by the amplitude of its vibrations, that light acts upon the formation of coloring-matter. An analogous example is furnished by the Proteus, which, having been drawn out from its dark hole, becomes gradually colored by light. We may compare with these observations that the negro baby is, when first born, of only slightly different color from the white; and the fact that certain parts of his body may already show the negro tinge does not contradict our theory of the dependence of the color on the action of light, but is only the mark of a hereditary tendency to become black. I do not intend to assert that light is the sole cause of pigment-coloration, for that would be contrary to the facts; but it is generally the exciting and sometimes the necessary means for the development of the coloring-matter. It plays a part like that of the spark in combustion, which has no effect upon an incombustible body, in the same way that light produces no colorizing effect upon an albino. There is, then, an aptitude to become colored, which varies according to races, and may not always exist. The question, however, of the ultimate cause of coloration is not solved, but only pushed back; for we are ignorant of the cause of this aptitude, and are obliged, to explain it, to have recourse to the laws of heredity and natural selection.

The rich coloration of deep-sea animals apparently contradicts the facts we have cited, but does not really do so. For it is principally the red, or less refrangible, neutral rays, the passage of which is interrupted by the water, while the blue, violet, and ultra-violet rays, which are the active ones in coloration, pass through it to a considerable depth. Furthermore, we know that the molecules composing the tissues of these animals are subject to vibratory movements analogous to those of light, which are represented to us by phosphorescence; and we may conceive those vibrations to be intense enough to produce a coloration like that which is the effect of sunlight.

As a rule, the parts of animals most exposed to rays of light are, other things being equal, richest in coloring-matter. The backs of wild animals are usually and with few exceptions (as among nocturnal and burrowing animals) more strongly colored than their bellies. Another class of exceptions may be seen among fishes of certain families which lie on their sides instead of on their bellies, and expose, not their backs, but one of their sides to the light. In these fishes the upper side is colored, while the under side, next to the ground and the darkness, is not. Articulates also have their upper sides most strongly colored, although what in them answers most nearly to the dorsal column is next to the ground. The parts of the shells of mollusks which are in contact with the ground are uncolored, while the parts exposed to the light shine with varied tints ; and this, whatever may be the peculiar positions assumed by particular shells.

For individuals of the same race, the abundance of the coloring-matter is generally proportioned to the intensity of the light to which they are exposed. This fact is generally understood, though exact observations bearing upon it are not as numerous as it is desirable they should be. It is well known that the skin is tanned by light, that people from the north are browned by living in the south, and that ruddiness and freckles appear under the action of the sunlight. Some peoples of the white race, like the Hindoos and the Moors, that live in southern climates, are frequently darker-skinned than the negroes themselves. Still, we can not affirm that light is the only cause of these changes.

Mr. Gould has observed that birds are more strongly colored when they live in countries having a clear sky than on islands or the sea-shore. Berchstein says that the colors of the plumage of cage-birds are affected by the shade in which they are kept. Mr. Allen has shown that the color of several species in the United States changes as we go from north to south.

On account of their close relations with one another, it is hard to distinguish the effects of heat on color from those of light. External temperature can not have much effect upon the skin of warm-blooded animals whose bodies are kept by the internal heat at a uniform degree ; but with the fur it is different, and it is possible that cold may induce an abstraction of coloring-matter from the hairs, and that the white color of animals of the polar zone may be partly owing to this fact. According to Pallas, the horse and the cow in Siberia become paler during the winter. The ermine seldom becomes as white during winter in England as in Norway. Its summer color persists till late in the season, when the extreme cold comes on, and then changes in a few days. The isatis fox, which in the polar regions becomes white in winter from brownish-gray, changes but little when taken to Europe. The Alpine hare does not put on its white dress at a fixed period, but at a time that depends on the greater or less earliness of the beginning of winter.

Mr. Nicholas Wagner, using an exceedingly sensitive galvanometer, has discovered fixed currents in the wings of butterflies; and, with the aid of electric currents, has succeeded in producing changes in the color and disposition of their pigments. What part electricity may play in this matter is still, however, unsettled.

In regard to the effects of feeding, Darwin cites cases of complete changes in the color of birds brought about by modifications of their alimentation. Bullfinches, fed with hemp-seed, turned black. The common green paroquet, fed with the fat of certain fishes, became striped with red and yellow.

Volumes have been written on the influence of natural selection upon color, and have elucidated the subject so fully that we need not dwell on it at length. The principal aspect in which the influence asserts itself is that in which the prevailing color among animals gives them a kind of resemblance to the ground on which or the medium in which they live, or to the objects by which they are surrounded, so that they are more readily hidden from their enemies. In other cases they are made conspicuous in color or to resemble disagreeable objects, so that their enemies, mistaking them for something else, shall avoid them. Such cases belong to the classes of phenomena which Mr. Wallace has grouped under the designation of protective mimicry. In other cases, certain colors may be associated with peculiarities that render the animal more capable of resisting peculiar conditions to which it may be exposed; when natural selection, aided by selection by the breeder, may contribute to preserve this color to the exclusion of others. Thus, according to Darwin, in Virginia, black hogs alone can endure a course of feeding consisting largely of the roots of *Lachnantes tinctoria;* so a race of black hogs became established in that country.

Much more might be said on this subject. We might consider the phenomena of sexual selection to which male birds largely owe their bright plumage; the heredity of colors, correlative variations, and the complex and obscure action of domestication; the action of moisture and of some secreted principles; and the distribution of colors as related to geographical regions. What I have said has been really only introductory to the subject, and for the purpose of reminding investigators what a full field of work they might find in exhaustively following it up.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

THE MOTOR CENTERS AND THE WILL.*

By VICTOR HORSLEY, F. R. C. S.

MY subject being the mechanism of the will, it might be asked, "What has a surgeon to do with psychology?" To which I would answer, "Everything." For, without sheltering myself behind Mr. Jonathan Hutchinson's trite saying that "a surgeon should be a physician who knows how to use his hands," I would remind you that pure science has proved so good a foster-mother to surgery, that diseases of the brain which were formerly considered to be hopeless, are now brought within a measurable distance of the knife, and therefore a step nearer toward cure. Again, I would remind you that surgeons rather than physicians see the experiments which so-called Nature is always providing for us—experiments which, though horribly clumsy, do on rare occasions, as I shall presently show you to-night, lend us powerful aid in attempting to solve the most obscure problems ever presented to the scientist.

The title I have chosen may possibly be objected to as too comprehensive; but until we are ready to admit a new terminology, we must employ the old in order to convey our meaning intelligibly, although there may be coupled therewith the risk of expressing more than we desire. Thus, when I speak of the mechanism of the will and the motor centers of the brain, I do not intend (as indeed must be obvious) to discuss the existence of the so-called freedom of the will, or the source of our consciousness of voluntary power.

I shall rather describe to you first the general plan of the mechanism which conveys information to our brain, the thinking organ; next the arrangement of those parts in it which are concerned with voluntary phenomena; and, finally, I shall seek to show by means of experiment that the consciousness of our existing as single beings, the consciousness of our possessing but one will, as people say, while at the same time we know that we possess a double nervous system, is due to the fact that pure volition is dependent entirely on the exercise of the attention which connotes the idea of singleness; consequently, that it is impossible to carry out two totally distinct ideas at one and the same moment of time, when the attention must, of course, be fully engaged upon each.

I fear that, in making my argument consecutive, I shall have to pass over very well-beaten paths, and so I must ask your patience for a few moments while I make good my premises. The nervous system, which in man is composed of brain, spinal cord, nerves, and nerve-endings, is arranged upon the simplest plan, although the details of

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the same become highly complex when we arrive at the top of the brain.

At the same time, while we have this simple plan of structure, we find that there is also a fundamental mode of action of the same—a mode which is a simple exposition of the principle, no effect without a cause—a mode of action which is known as the phenomenon of simple reflex action.

The general plan of the whole nervous system is illustrated by this model. Imbedded in the tissues all over the body, or highly specialized and grouped together in separate organs, such as the eye or ear, we find large numbers of nerve-endings—that is, small lumps of protoplasm from which a nerve-fiber leads away to the spinal cord and so up to the brain. These nerve-endings are designed for the reception of the different kinds of vibration by which energy presents itself to us. As the largest example of these nerve-endings, let me here show you one of the so-called Pacinian bodies, or, more correctly, Marshall's corpuscles, for Mr. John Marshall discovered these bodies in England before Pacini published his observations in Italy. Here you see one of these small oval bodies arranged on the ends of one of the nerves of the fingers, and here you see the nerve-fiber ending in the little protoplasmic bulb which is protected by a number of concentric sheaths. Pressure or any form of irritation of this body at the end of the nerve-fiber causes a stream of nerve-energy to travel through the spinal cord to the brain, and so we become conscious that something is happening to the finger.

Here in this section of the sensitive membrane of the back of the eye, the retina, you see a similar arrangement, only more complicated —namely, nerve-fibers leading away from small protoplasmic masses which possess the property of absorbing light and transforming it into nerve-energy. It is this transformation of nerve-energy into heat, light, pressure, etc., which it seems to me should alone be called a sensation, irrespective of consciousness. And, in fact, we habitually say we *feel* a sensation. The terms "feeling" and "sensation," however, are frequently used as interchangeable expressions, although, as I shall show you directly, "feeling" is the conscious disturbance of a sensory center in the surface of the brain, and in fact feeling is the conscious perception of sensations. This distinction between feeling and sensation, if dogmatic, will save us from dispute as to the meaning of the word "sensation"; and, further, the distinction is one, as I have just shown, which is justified by custom.

Now, the nerve-fiber which conveys the energy of the sensation is a round thread of protoplasm which in all probability connects the nerve-ending with a sensory corpuscle in the spinal cord. These nerve-fibers running in nerves are white, whereas, as you know, protoplasm is gray. They are white because each is insulated from its fellow by a white sheath of fatty substance, just as we protect telegraph-wires with coatings. It is not stretching analogy too far to say that nerve-force may probably escape unless properly insulated.

In consequence of the fibers being covered with these white sheaths, they form what is called the white matter of the brain; while the nerve-centers are grayish, and therefore form what is called the gray matter of the brain, so that the gray matter receives and records the messages conveyed to it by the white insulated fibers.

From the sensory corpuscle, which is a small mass of protoplasm provided with branches connecting it to neighboring corpuscles, the nerve-energy, if adequate, passes along a junction thread of protoplasm to a much larger corpuscle, which is called a motor corpuscle, and the energy of which, when liberated by the nerve impulse from the sensory corpuscle, is capable of exciting muscles into active contraction. These two corpuscles form what is called a nerve-center.

Not only are the motor corpuscles fewer as well as much larger than the sensory ones, but also the nerve-fibers which go out from them are larger too. In fact, it would seem as if we had another close analogy to electrical phenomena; for here, where we want a sudden discharge of a considerable intensity of nerve-force, we find to hand a large accumulator mechanism and a large conductor, the resistance of which may justly be supposed to be low. Finally, the motor nerve-fiber terminates in a protoplasmic mass which is firmly united to a muscle-fiber, and which enables the muscle-fiber to contract and so cause movement of one or more muscles. Now, with this idea of the general plan on which the whole nervous system is constructed, you will understand that muscular action—i. e., movement—will occur in proportion to (1) the intensity of the stimulation of the sensory corpuscle; and (2) the resistance in the different channels. When a simple flow through the whole apparatus occurs, it is called a simple reflex action, and this was discovered in England by Dr. Marshall Hall.

To recapitulate: A nerve-center, theoretically speaking, we find to consist of a sensory corpuscle on the one hand and a motor corpuscle on the other, both these being united by junction threads or commissures. To such a center come sensations or impressions from the nerve-endings, and from such a center go out impulses which set the muscles in action.

I have dwelt thus at length on this most elementary point, because it appears to me that, in consequence of the rapidity with which function is being demonstrated to be definitely localized in various portions of the cerebral hemispheres, we are in danger of losing sight of Dr. Hughlings-Jackson's grand generalizations on nerve-function, and that we are gradually inclining to the belief that the function of each part is very distinct, and therefore can most readily act without disturbing another part. In fact, we are perhaps drifting toward the quicksands of spontaneity, and disregarding entirely the facts of every-day life which show that every cycle of nerve-action includes a disturbance of the sensory side as well as the active motor agency. Did we, in fact, admit the possibility of the motor corpuscle acting *per se*, and in the absence of any sensory stimulation, we should again be placed in the position of believing that an effect could be produced in the absence of a cause.

For these reasons such a center has been termed kinæsthetic or sensori motor, and such centers exist in large numbers in the spinal cord, and they perform for us the lower functions of our lives without arousing our consciousness or only the substrata of the same.

But now, turning to the brain, although I am extremely anxious to maintain the idea just ennunciated that, when discussing the abstract side of its functions we should remember the sensori-motor arrangement of the ideal center, I shall have to show you directly that the two sides—namely, the sensory and motor—in the brain are separated by a wide interval, and that in consequence we have fallen into the habit of referring to the groups of sensory and motor corpuscles in the brain as distinct centers. I trust you will not confuse these expressions, this unfortunately feeble terminology, and that you will understand, although parts may be anatomically separated and only connected by commissural threads, that functionally they are closely correlated. In consequence of the bilateral symmetry of our bodies we possess a double brain—a practically symmetrical arrangement of two intimately connected halves or hemispheres which, as you know, are concerned with opposite sides of the body, for the right hemisphere moves the left limbs, and *vice versa.*

For my purpose it will be sufficient if we regard the brain as composed of two great collections of gray matter or nerve-corpuscles which are connected with sensory nerve-endings, with muscles, and intimately with one another.

In this transverse section of a monkey's brain, which is stained dark-blue to show up its component parts, you will see all over the surface a quantity of dark-gray matter, which is simply the richly convoluted surface of the brain cut across. Observe, it is about a quarter of an inch deep, and from it lead downward numerous white fibers toward the spinal cord. The surface of the brain, the highest and most complicated part of the thinking organ, is called the cortex, bark, or rind, and in it are arranged the motor centers I am about to describe. These white fibers coming away from it to the cord, not only are channels conveying messages down to the muscles, but also carrying messages from the innumerable sense-corpuscles all over the body.

So much for one gray mass of centers. Now, down here at the base of the brain you see two lumps or masses of the same nature, and these are called, therefore, the basal ganglia or gray masses. Since they are placed at the side of the paths from the cortex, and undoubtedly do not interfere with the passage of impulses along those paths, we may put them aside, remembering that they probably are concerned with low actions of the nervous system, such as eating, etc., which are popularly termed automatic functions.

In this photograph of a model made by Professor Aeby, of Berne, you see represented from the front the two cerebral hemispheres with the centers in the cortex as little masses on the surface, and the basal ganglia as darker ones at the bottom, while leading from them down into the spinal cord are wires to indicate the channels of communication.

Note, in passing, that both hemispheres are connected by a thick band of fibers called the "corpus callosum." It is, I believe, the close union thus produced between the two halves that leads in a great measure (though not wholly) to consonance of ideas.

The arrangement of the fibers will be rendered still clearer by this scheme, in which the cortex is represented by this concave mass, and the fibers issuing from the same by these threads. The basal ganglia would occupy this position, and they have their own system of fibers.

I will now leave these generalizations, and explain at once the great advance in our knowledge of the brain that has been made during the last decade. The remarkable discovery that the cortex or surface of the brain contained centers which governed definite groups of muscles, was first made by the German observers Hitzig and Fritsch; their results were, however, very incomplete, and it was reserved for Professor Ferrier to produce a masterly demonstration of the existence and exact position of these centers, and to found an entirely new scheme of cerebral physiology.

The cortex of the brain, although it is convoluted in this exceedingly complex manner, fortunately shows great constancy in the arrangement of its convolutions, and we may therefore readily grasp the main features of the same without much trouble. From this photograph of the left side of an adult human brain you will see that its outer surface or cortex is deeply fissured by a groove running backward just below its middle, which groove is called the "fissure of Sylvius," after a distinguished mediæval anatomist. This fissure, if carried upward, would almost divide the brain into a motor half in front and a sensory half behind.

Of equal practical importance is another deep fissure which runs at an open angle to the last, and which is called the "fissure of Rolando," Rolando being another pioneer of cerebral topography. Now, it is around this fissure of Rolando that the motor side of the centers for voluntary movement is situated; and when this portion of the cortex is irritated by gentle electric currents, a constant movement follows according to the part stimulated.

Because of their upward direction, the convolutions bounding the fissure of Rolando are called respectively the "ascending frontal" and "ascending parietal" convolutions. Now here, at the lowest end of the fissure of Rolando, we find motor areas for the movement of both sides of the face: that is to say that, as regards this particular piece of the cortex, it has the power of moving not only its regular side of the face, the right, but also the left—that, in fact, both sides of the face move by impulse from it.

Higher up we find an area for movement of the opposite side of the face only. I reserve for a moment the description of this portion of the brain, and pass on to say that above these centers for the face we find the next is for the upper limb, and most especially the common movement of the upper limb—viz., grasping, indeed the only forward movement which the elbow is capable of, namely, flexion. The grasping and bringing of an object near to us is the commonest movement by far, and we find here that this center is mainly concerned in it. Behind the fissure of Rolando, Dr. Ferrier placed the centers for the fingers. Next above the arm area is a portion of the cortex which moves the lower limb only, and in front of this again is an area for consonant action of the opposite arm and leg. Let me here remind you that this being the left hemisphere, these are the centers for movement of the opposite, that is, the right limbs, and that in the other hemisphere there are corresponding areas for the left limbs.

Thus here we have mapped out those portions of the cortex which regulate the voluntary movement of the limbs. So far I have omitted mention of the muscles of the trunk, namely, those which move the shoulders, the hips, and bend and straighten the back. Dr. Ferrier had shown that there existed on the outer surface of the cortex, here, a small area for the movement of the head from side to side.

Professor Schäfer and myself have found that the large trunk-muscles have special areas for their movement, ranged along the margin of the hemisphere, and dipping over into the longitudinal fissure. Thus all the muscles of the body are now accounted for, and I will first draw special attention to the fact that they are arranged in the order, from below upward, of face, arm, leg, and trunk.

The consideration of this very definite arrangement led Dr. Lauder Brunton to make the ingenious suggestion that it followed as a necessary result of the progressive evolution of our faculties. For, premising, in the first place, from well-ascertained broad generalizations, that the highest center, physically speaking, is also the highest functionally and most recent in acquirement, we find that the lowest is the face, and then we remember that the lowest animals simply grasp their food with their mouth. I imagine it is scarcely necessary for me to repeat the notorious confession that our faculties are arranged for the purpose of obtaining food as the primary object of what is called bare existence.

Proceeding upward in the scale of evolution, we next find animals which can grasp their prey and convey it to the mouth, and so we find next to the face area evolved that for the arm. And so on, the next step would be the development of the legs to run after the prey, and here is the leg-center; while, finally, the trunk-muscles are dragged in to help the limbs more effectually. To my mind this idea receives overwhelming support from the consideration of the fact that, the higher our centers are, the more they require education; the infant, for instance, in a few days shapes its face quite correctly to produce the food-inspiring yell, yet takes months or years to educate its upper limbs to aid it in the same laudable enterprise. Finally, what terrible probation some people pass through at the hands of dancing-masters before their trunk-muscles will bend into the bow of politeness!

Now to return to the lower end of the fissure of Rolando, to the areas for movements of the face: it was long ago pointed out by the two Daxes and Professor Broca that when this portion of the brain immediately in front of the face area was destroyed, the person lost the power of articulate speech, or was only capable of uttering injections and customary "strange oaths." In fact, this small portion of the left side of our brains (about one and a half square inch) is the only apparatus for expressing our thoughts by articulating sounds, and note particularly that it is on the left side. The corresponding piece on the right side can not talk, as it were. This remarkable state of things is reversed in left-handed people. In these the right hemisphere predominates; and so we find that, when this portion was diseased, there followed aphasia, as it is called. While, however, the right side customarily says nothing, it can be taught to do so in young people, though not in the aged.

Before leaving these motor areas, let me repeat, by way of recapitulation, that the only truly bilaterally acting areas are those for the lower facial and throat muscles. This is a most important fact, for the idea has recently been propounded that both sides of the body are represented in each motor region of each hemisphere. That is to say, each motor area has to do with the movements of both upper limbs, for example. In support of my contention that this is not in accordance with clinical facts, let me here show you photographs of the brain of a man who was unfortunate enough to suffer destruction of the fibers leading from one motor area. Here you see a puncture in the brain which has caused hæmorrhage beneath the fissure of Rolando and the motor convolutions in front and behind it.

In this transverse section of the same spot you see that the hæmorrhage has plowed up the interior of the brain. Here is the cortical gray matter, but its fibers leading down to the muscles are all destroyed. Now, in examining this patient I asked him to move his left arm or leg; he was perfectly conscious, and, understanding the question, made the effort, as we say, but no movement occurred. Now, if both sides of the body are represented in each hemisphere, it seems to me that such a case would be impossible, or at least that a little practice would enable the other hemisphere to do the work ; but all clinical facts say that, once destroyed, the loss is never recovered.

If we examine this motor region of the cortex with the microscope, we of course find these large corpuscles, which we have learned are those which alone give energy to the muscles. But you must not imagine that the motor region consists solely of these corpuscles. On the contrary, as you see in this diagram, we have several layers of corpuscles. I shall return to this arrangement of the corpuscles directly.

Looking back at the surface of the brain, you notice that I have only accounted for but a small portion of the cortex. Dr. Ferrier was the first to show that the portion of cortex which perceived (and I use the word in its strictest sense) the sensation of light was this part, and it is therefore called the "visual center or area." From recent researches it would appear that we must give it the limits drawn on this diagram ; below it we find the center for hearing. Thus we know where two sense perceptive centers are situated.

Microscopical investigation shows that this sensorial portion of the cortex is very deficient in large corpuscles, and is correspondingly rich in small cells. Here in this diagram you see these two kinds of structure in the cortex cerebri. Note the greater number and complication of the small corpuscles in the sensory part of the cortex, and the comparatively fewer though much larger corpuscles in the motor region.

It seems to me that several beliefs are justified by these facts : In the first place, the movements produced by the action of these motor centers are always the same for the same center ; consequently, it has only one thing to do, one idea, as it were. Thus, for instance, bending of the arm : this action can only vary in degree, for the elbow will not permit of other movements. Hence we may look upon it as one idea. Now, observe that where one idea is involved we have but few corpuscles. Next, consider the multitude of ideas that crowd into our mind when we receive a sensation. One idea, then, rapidly calls up another, and so we find anatomically that there are a corresponding much greater number and complication of nerve-corpuscles. To sum up, I believe we are justified in asserting that where in the nervous system a considerable intensity of nerve-energy is required—e. g., for the contraction of muscles—you find a few large corpuscles and fibers provided ; and that where numerous ideas have to be functionalized, there numerous small corpuscles are arranged for the purpose.

But, now, the special interest attaching to the sensory perceptive areas is that they, unlike the motor areas, tend to be related to both sides of the body. With our habit of constantly focusing the two eyes on one object, it will strike you at once that habitually we can only be attentively conscious of one object at a time, since both eyes are engaged in looking at it, and, as you know, we can not as a matter of fact look at two things at once.

Hence, I take it, both sensory perceptive centers are always fully occupied with the same object at the same moment, and that therefore we have complete bilateral representation of both sides of the body in each hemisphere. As a further consequence, each sensory perceptive area will register the idea that engaged it; in other words, both centers will remember the same thing. Thus it happens that each sensory area can perform the duty of the other, and therefore it is a matter of comparative indifference whether one is destroyed or not, and as a matter of fact when this happens we find that the person or animal recognizes objects as they actually are, and in fact has no doubt as to their nature. Here you see anatomically the reason of this peculiarity is found to be that the optic or seeing nerves cross one another incompletely in going to each hemisphere, and thus each sensory center represents half of each eyeball.

I must pass rapidly to the description of the rest of the surface of the brain—the hinder and front ends. At the outset I must admit that all our knowledge concerning them is very hypothetical in the absence of positive experimental results.

This much we can say, that they are probably the seats of intellectual thought, for many reasons which I have not time to detail. Further, we know that these intellectual areas are dependent for their activity entirely on the sensory perceptive centers, for the dictum that there is no consciousness in the absence of sensory stimulation is very well established, as I shall now show you, however astounding it may appear. In the first place, you will remember that when we wish to encourage that natural loss of consciousness which we call sleep, we do all we can to deprive our sense-organs and areas of stimulation. Thus we keep ourselves at a constant temperature, we shut off the light, and abolish all noises if we can. But a most valuable observation was made a few years ago by Dr. Strümpell, of Leipsic, who had under his care a youth, the subject of a disease of the brain, etc., which, while destroying the function of one eye and ear, besides the sensibility to touch over the whole body, still left him when awake quite conscious and able to understand, etc., using his remaining eye and ear for social intercourse. Now, when these were carefully closed he became unconscious immediately, in fact slept, and slept until he was aroused again, or awoke naturally, as we say, after some hours. Hence the higher functions of the brain exercised when that organ is energizing the reasoning of the mind are absolutely dependent upon the reception of energy from the sense perceptive areas.

But my only point with reference to this part of the brain is to attempt to determine how far they are connected with the motor centers in the performance of a voluntary act. With the mechanism of choice and deliberate action I have nothing to do; but there can be no doubt that the part of the brain concerned in that process of the mind is directly connected with the motor region, as indicated on this diagram, to which I would now return. From what I have here written you read, arranged schematically, the psychical processes, which, for the sake of argument, we may assume are carried on by the mind in these portions of the cortex.

I wish to point out that we have structurally and physiologically demonstrated with great probability the paths and centers of these psychical actions. There is no break: the mere sight of an object causes a stream of energy to travel through our sense areas, expanding as it goes by following the widening sensory paths here represented, and at the same time we feel our intellect learns that new ideas are rising up and finally expand into the process of deliberate thought, concerning which all we know is from that treacherous support, namely, introspection.

Then come impulses to action, and these follow a converse path to the receptive one just described; the nerve-energy is concentrated more and more until it culminates in the discharge of the motor corpuscles. We might represent the whole process of the voluntary act by two fans side by side, and the illimitable space above their arcs would serve very well to signify the darkness in which we sit concerning the process of intellectual thought.

What I have hastily sketched is the outline of the process of an attentive or voluntary act. I say attentive advisedly, for I wish now to put forward the view that the proper criterion of the voluntary nature of an act is not the mere effort that is required to perform it, but is the *degree to which the attention is involved.* The popular view of the volitional character of an act being decided by the effort to keep the action sustained is surely incomplete, for in the first place we are not seeking to explain our consciousness of an effort; we endeavor to discover the causation of the effort. Our sense of effort only comes when the will has acted, and that same sense is no doubt largely due to the information which the struggling muscle sends to the brain, and possibly is a conscious appreciation of how much energy this motor corpuscle is giving out.

Now, to give you an example. I see this tambour, and decide to squeeze it, and do so. Now, this was a distinctly voluntary act; but the volitionary part of it was not the effort made, it was the deliberate decision to cause the movement. I may now point out that in this whole process we say, and say rightly, that our attention is involved so long as we are deliberating over the object; that as soon as another object is brought to us our attention is distracted, that is to say, turned aside.

All writers are agreed that the attention can not be divided, that we really only attend to one thing at once. It seems to me that this is so obvious as not to require experimental demonstration; but I have led up to this point because I now wish to refer to the third part of my subject, namely, the question as to whether we have a really double nervous system or not. But, by way of preface, let me repeat that, although we may have a sub-consciousness of objects and acts, that sub-conscious state is true automatism, and that such automatic acts are in no sense voluntary until the attention has been concentrated upon them. For example, again I press this tambour, because I desire to raise the flag, and I keep that raised while I attend to what I am saying to you. My action of keeping the flag raised is only present to my consciousness in a slight or subordinate degree, and does not require my attention, deliberate thought, or choice, and therefore, I repeat, is not a voluntary action ; in fact, it could be carried on perfectly well by this lower sensori-motor center, which only now and then sends up a message to say it is doing its duty, in the same way as a sentry calls out "All is well" at intervals.

But to return. In consequence of the obvious fact that we have two nerve-organs, each more or less complete, some writers have imagined that we have two minds ; and to the Rev. Mr. Barlow, a former secretary of this Institution, is due the credit of recognizing the circumstances which seem to favor that view. It was keenly taken up, and the furore culminated in a German writer (whose name, I am ashamed to say, has escaped me) postulating that we possess two souls.

Now, the evidence upon which this notion rests, that the two halves of the brain might occasionally work independently of one another at the same moment, was of two kinds. In the first place it was asserted that we could do two different things at once, and in the second place evidence was produced of people acting and thinking as if they had two minds.

Now, while of course admitting that habitually one motor center usually acts at one moment by itself, I am prepared to deny *in toto* that two voluntary acts can be performed at the same time, and I have already shown what is necessary for the fulfillment of all the conditions of volition, and that these conditions are summed up in the word attention.

Further, I have already shown that, when an idea comes into the mind owing to some object catching the eye, both sensory areas are engaged in considering it. It seems to me I might stop here, and say that here was an *a priori* reason why two simultaneous voluntary acts are impossible ; but as my statements have met with some opposition, I prefer to demonstrate the fact by some experiments.

The problem, stated in physiological terms, is as follows : Can this right motor region act in the process of volition, while at the same time this other motor area is also engaged in a different act of volition ? Some say this is possible ; but in all cases quoted I have found that sub-conscious or automatic actions are confused with truly voluntary acts. I mean that such automatic acts as playing bass and treble are not instances of pure volition, as the attention is not engaged on both notes at once.

Consider for a moment the passage of the nerve impulses through the brain that would have to occur. At the outset we find that the sensory perceptive centers would have to be engaged with two different ideas at once; but Lewes showed long ago that introspection tells us this is impossible, that "consciousness is a seriated change of feelings": he might equally well have said ideas. And, again, we know that when two streams of energy of like character meet, they mutually arrest each other's progress by reason of interfering with the vibration-waves.

I will show directly that this is actually the case in the action of the cortex when the above-mentioned dilemma is presented to it. The experiment I have devised for this purpose is extremely simple. A person who is more or less ambidextrous, and who has been accustomed for a long time to draw with both hands, attempts to describe on a flat surface a triangle and circle at the same moment. I chose these figures, after numerous trials, as being the most opposite, seeing that in a triangle there are only three changes of movement, while in a circle the movement is changing direction every moment. To insure the attempt to draw these figures simultaneously succeeding, it is absolutely necessary that the experimenter should be started by a signal.

When the effort is made, there is a very definite sensation in the mind of the conflict that is going on in the cortex of the brain. The idea of the circle alternates with that of the triangle, and the result of this confusion in the intellectual and sensorial portions of the brain is that both motor areas, though remembering, as it were, the determination of the experimenter to draw distinct figures, produce a like confused effect, namely, a circular triangle and a triangular circle. If the drawing is commenced immediately at the sound of the signal, it will be found that the triangle predominates; thus, if I determine to draw a triangle with my left hand and a circle with my right, the triangle (though with all its angles rounded off) will be fairly drawn, while the circle will be relatively more altered, of course made triangular. On the other hand, if the two figures are not commenced simultaneously, it will be found that usually the one begun last will appear most distinct in the fused result, in fact, will very markedly predominate.

Now, the course of events in such an experiment appears to be clear. The idea of a triangle and circle having been presented to the intellect by the sensory centers, the voluntary effort to reproduce these is determined upon. Now, if we had a dual mind, and if each hemisphere was capable of acting *per se*, then we should have each intellectual area sending a message to its own motor area, with the result that the two figures would be *distinct* and *correct*, not fused.

The other evidence that I referred to above, which is adduced in favor of the synchronously independent action of the two hemispheres is from the account of such cases as the following: Professor Ball, of

Paris, records the instance of a young man who one morning heard himself addressed by name, and yet he could not see his interlocutor. He replied, however, and a conversation followed, in the course of which his ghostly visitant informed him that his name was M. Gabbage.

After this occurrence he frequently heard M. Gabbage speaking to him. Unfortunately, M. Gabbage was always recommending him to perform very outrageous acts, such as to give an overdose of chlorodyne to a friend's child, and to jump out of a second-floor window. This led to the patient being kept under observation, and it was found that he was suffering from a one-sided hallucination. Similar cases have been recorded in which disease of one sensory perceptive area has produced unilateral hallucination.

I can not see that these cases in any way support the notion of the duality of the mind. On the contrary, they go to show that while as a rule the sensory perceptive areas are simultaneously engaged upon one object, it is still possible for one only to be stimulated, and for the mind to conclude that the information it receives in this unusual way must be supernatural, and at any rate proceeding from one side of the body.

To conclude, I have endeavored to show that as a rule both cerebral hemispheres are engaged at once in the receiving and considering one idea; that under no circumstances can two ideas either be considered or acted upon attentively at the same moment; that therefore the brain is a single instrument.

It now appears to me that one is justified in suggesting that our idea of our being single individuals is due entirely to this single action of the brain.

Laycock showed that the Ego was the sum of our experience, and every writer since confirms him. But our experience means (1) our perception of ideas transmitted and elaborated by the sensory paths of the brain; and (2) our consciousness of the acts we perform. If, now, these things are always single, the idea of the Ego surely must also be single.—*Nature.*

HOME-LIFE OF THE THIBETANS.*

By CHARLES H. LEPPER.

THIBET! how little does the name of that unexplored and jealously exclusive country convey to the average European! To the scientific it is known as the most extensive and highest table-land in the world, the water-parting from whence the majority of the largest and longest rivers in the world derive their sources. It is also

* From an article on Thibet in the "Nineteenth Century."

the Rome of the Buddhist religion of the present day, and upon the miscalled "Lama" priesthood is bestowed the undeserved reputation of much learning and the possession of the secrets of ancient mystical and occult science. While tempted to consider the Thibetans from a European stand-point as, if not effete, at all events a semi-barbarous people, it only requires a moment's consideration of the striking fact that, notwithstanding its thousands of miles of frontier, no European can now evade their frontier-guards at any point along those thousands of miles, for it to become apparent that a country with a government which can organize and maintain such a marvelous and efficient system can hardly in reason be called effete. Effete it certainly is not; and yet, strange to say, notwithstanding this apparent evidence of its power, there is probably no country in the world of equal size which contains within itself such real weakness from a political point of view, and which could be so easily made a prey of by a designing neighbor. To arrive at that conclusion it is necessary to thoroughly understand the internal economy of that strange country, and so little is known concerning its people that no apology is necessary for entering into such minute details as space will admit of in this glance at its people and their habits, customs, government, and religious system.

To begin, and in order to familiarize the reader with the surroundings and conditions of life of the people under description, let us picture a typical Thibetan house.

The outside walls are generally of stone, set in a very inferior kind of mortar, but oftener in a bedding of puddled mud. When clay is available the builders much prefer to have only the foundations of stone and the walls above-ground of well-prepared clay, which latter they build up between plank molds. These are removed as each layer is finished, and then raised to act as molds for the next layer.

The houses have two stories, and frequently there is a shed along one side of the roof, in which the inhabitants work when the sun is oppressive. A great part of their work is done on the flat roof, such as thrashing grain, etc. The ground-floor is devoted to the cattle—horses and pigs, etc. The fowls usually roost with the family on the first floor. The construction of the floor of the upper story is sufficiently curious. Its main supports are cross-beams; on these smaller beams are placed at right angles, on which are laid slabs of wood; on these again are laid small twigs like broom, and then a coating of mud plaster is spread, on which the planks are finally placed. A hole is left in this floor for their primitive ladder (a piece of wood with notches cut in it), up through which hole ascend all the effluvia from the animals below!

There is only one door for the whole house. In front of this door there is generally a court-yard surrounded by walls. All the manure and refuse is allowed to remain *in situ* under the house, and in the court, all the year through, till shortly before the season for manuring the fields, when it is all collected into a big heap and left to ferment there from a fortnight to three weeks, after which it is spread over the land.

The larger houses have one or more wings and a veranda. The floor forming the roof is made in the same way as the other, only there is an addition of cow-dung to the mud instead of planks, and the plaster thus made is beaten for days with sticks to make it amalgamate, as in India. All cracks, as the plaster dries, are carefully filled up with fresh plaster till the whole is a good solid roof and floor combined, and very well adapted for thrashing.

The common-room is the kitchen on the first floor in which they all sleep, with their heads toward the fireplace, never with their feet toward the fire, as that is considered an insult or affront in their etiquette. In summer they sleep on the roof.

The Thibetans who live in the valleys are not as a rule fine men physically, but the highlanders, or hill-men, such as the shepherds, etc., up in the high Thibetan mountains, are massive *beaux hommes*, having somewhat the appearance of having been hewed out of solid blocks.

The people of the valleys are more or less idle gossips, disliking work intensely. The men do no work in the fields except plowing, and few who can afford to pay another to do it for them will do even that much. When not in repose—i. e., when not absolutely doing nothing—the men occupy themselves by sewing, spinning, looking after the mules, horses, and cattle, but above all in attending to the petty business of the family. The women sow, irrigate, weed, cut the harvest, thrash, winnow, carry the grain to the granary, and do all the housework as well. If there are loads to be carried, the women carry them. If a man be asked to carry a big case or heavy load, he is certain, on seeing it, to say at once, "That! that's a woman's load," and of the baggage he will select the smallest parcel he can find as his burden. In the pasturages, the women milk, make the butter, and look after the flocks when these are grazing near the tents or encampment. The men herd the flocks when grazing at a distance. The women ride as well as the men, and in the same fashion. From constantly throwing stones at the cattle the women are adepts at this, and can and do make it very unpleasant for any person who may have irritated them into putting their science into practice. Dirt is the ruling feature everywhere in Thibetan households. It pervades their houses and their persons, prevails in their customs, and gives a tone to and bears fruit in their speech.

A European, an English official in India, once desiring to see the real color of the Thibetan skin, paid the parents of a child to have it washed in hot water, several waters, and with an unlimited supply of soap. Every effort was made in vain, the skin could not be reached through such an armor-plating of dirt. It is said with every show of truth that it would be quite impossible to wash an adult Thibetan down to the skin. The beauty of a woman in Thibet consists in her being stout, broad, thick-set, and heavily membered, and the accomplishments to be desired are that she should be above all things audacious, a good hand at a bargain and at repartee; in fact, a typical Billingsgate virago, if massive enough, would pass as a Venus in Thibet.

The ordinary food of the country is barley that, having been parched, is afterward ground and called *Tsam pa*, or *Tsang pa*. This meal they moisten with tea made in the Thibetan manner—i. e., of boiled "brick-tea" buttered and salted—or else, if too poor to use tea, moistened with soup, by mixing it in a cup and working the paste round with the fingers against the side of the cup. They eat this paste soft and moist. Tea made of the filthy "brick-tea," boiled with butter, salt being added to taste, and the mixture well churned, is the ordinary drink of the country, soup taking its place among the poorer classes. There are, of course, other kinds of food, but the above is the staple. They have a kind of *chupatti*, or scone, a common food. They eat flesh, chiefly of pigs, and fowls, but all depends upon their locality and means. They have no established rules, customs, or fixed hours for eating, the nearest approach to a rule being to take what they can get on the spot when hungry. Tea, as stated above, is the chief drink, so much so that it has become the custom to ask people to come and "drink tea," when to come and eat dinner is really intended, and this even in cases where the family is too poor to provide tea, and no tea in such cases is expected. After tea, as favorite beverage, comes a kind of barley-beer called *Khiong* in the east, *Tchong* in the west, and then a kind of distilled barley-whisky called *A ra*. In the pasturages buttermilk is the ordinary drink, and curds and whey, called *Ta ra*, are in favor. On the days on which they boil their meat they prepare no tea, but use the broth as a drink instead, on economical grounds; and on broth-days they mix the *Tsam pa* with broth instead of tea.

Coming to the Thibetan costume. The men wear the *Tchru ba*, a long and thick woolen robe, sheepskin in winter, descending down till it would drag considerably on the ground if let loose. It is doubled well across the chest and front till the ends or edges almost meet the shoulders, where one edge is fastened under the right arm with a tape or string bow. In dressing, the man, having on his *Tchru ba* hanging loose about him, holds his sash or belt about on a level with the knees, or a little above them, and this he draws in to make a gather, and then the belt, with all of the robe above it, is drawn up and the belt fastened round the waist. This leaves a large pouch of course, falling over the belt all round, and leaves the foot of the robe about half-way between the knee and the calf. Into the pouch so formed they put anything they have to carry, such as their *Tsam pa* cup, and even little dogs, and sometimes little pigs.

At night, before lying down to rest, they take off their boots and belt, and with these make a pillow. They then judge their distance from the "pillow," and kick that part of their robe (now trailing on the ground after removing the belt) which they intend to lie on toward the "pillow"; thus by a kick converting one side of their *Tchru ba* into a mattress, and by this arrangement leaving themselves still the other side of the robe to act as a complete bed-covering on lying down; and all without undressing. Only the rich indulge in a carpet to sleep on, and rich people sometimes use a Chinese carpet. The above systim of bed-making is almost universally practiced throughout Thibet, or at all events throughout Eastern Thibet.

Women often wear the above costume, but it is not their proper dress, which is as follows: a kilted petticoat of woolen stuff, sometimes considerably decorated in colors with flowers, is so worn as to fall to about the ankles. In putting it on they commence on the left hip, pass it round the body once, and again across the front, thus having a double thickness in front; they fasten it on the right hip. This petticoat is made up of many narrow strips each a few inches wide, these being sewed together and kilted in such a manner as to have the pleats only down the sides, being quite plain both front and back. For a waist-band it has a strong strip of long-cloth sewed to its inner side. Attached to this waist-band is a sleeveless bodice, generally of cotton cloth, which is supported by bands over the shoulders, and this garment carries the weight of the petticoat. The bodice is doubled across the chest and tied on the right side at the neck, under the right arm and again lower down. They also wear a sash or *cummerband* some six inches in width and about ten feet long, with the ends falling loose from under the belt on the right side. This is the ordinary female attire, but, when they wish to dress better, they wear a sleeved chemise under the bodice; this, however, is very rarely worn at home in their houses or at work. On state occasions they wear a jacket with longer sleeves and longer body than the Chinese *ma quoi*, or *quen shen tze*, but something like it. This jacket is of silk or cotton or woolen cloth, etc., and falls to about half-way down the thighs. The sleeves descend some seven inches lower than the tips of the fingers, and are very full, though not so much so as the *ma quoi*. From the wrist to the ends of the sleeves the color is always different and of a more vivid and striking nature (sometimes red, green, etc.) than the stuff or material of the main portion. The collar is nearly always of red broadcloth, and is fastened by a large silver and coral brooch on the chest. The jacket is closed down the right side with galloons or braids of mixed and pronounced colors. They wear boots like those of the men, the tops being of woolen or colored cotton material, and the soles of leather. They very seldom wear any kind of hat. The coiffure varies much. Their ornaments are generally of silver (very rarely of gold) and precious stones, but chiefly of coral. The stones used are turquoise, lapis-lazuli, agate, aqua-marina, and amber, if the latter may be classed with the stones. They also wear ornaments made of a colored porcelain, etc. The very great people, such as governors, have large ornaments in gold. Most of their precious stones come from the neutral ground, or Singpho country, north of Upper Burmah, between the British province of Assam and China, also from India *via* Cashmere. When a woman prepares for sleep she simply wraps a man's *Tchru ba* round her head, and lets the skirts fall about her, rolling herself up in these, and, with her boots and belt for a pillow, she requires to seek no couch.

On the subject of trade very little can be said. Not that the trade is insignificant by any means, but the system can be summed up in the one word "peddling." Every family trades; the Lamasseries trade; the officials trade; but it is in every case conducted on the peddler system. Members of a family attend to the trade of the family, and travel immense distances with their laden mule and yaks, exchanging their goods at different places as they go along. Shops are almost unknown on any scale.

SKETCH OF SIR LYON PLAYFAIR.

IN Sir Lyon Playfair the British Association has for its president this year a gentleman who, to a thorough scientific training and a wide fame as a scientific man, unites a versatile adaptability to public affairs, and who has done many unquestionable services to the state in the lines of administration and of the advancement of great public questions. "He is eminent," says the writer of a sketch of him in an English paper, "as a scientific and practical chemist, a sanitary reformer, an educational reformer, a man of public business, an ex-minister, and late chairman of the Committee of Ways and Means in the House of Commons."

Dr. Playfair is a son of Mr. George Playfair, Chief Inspector-General of Hospitals of Bengal, and was born at Meerut, Bengal, May 21, 1819. He was taught at St. Andrews and afterward at Glasgow, where he studied chemistry under Sir Thomas Graham, till 1837, when he went to India for his health. Upon his return to England, with restored vigor, he rejoined Professor Graham, who was then in the London University, but soon after went to Giessen, where he continued his chemical studies, in the "organic" branch of the science, under Liebig, and translated some of that author's works into English. Upon his return to Scotland he became manager of the Messrs. Thompson's Calico-Printing Works at Clitheroe. In 1843 he was appointed Professor of Chemistry, succeeding Dalton, in the Royal Institution at Manchester. In the next year he was appointed, upon the recommendation of Sir Robert Peel, on the commission to examine into the sanitary condition of large towns and populous districts, on which subject he made reports which are described as characterized by great ability. This work done, he was appointed chemical professor in the Museum of Practical Geology in London. He was given an important part in the preparations for the Great Exhibition of 1851 in visiting the manufacturing districts, in the performance of which duty he drew up a classification of the objects of industry, and entered into personal communication with the manufacturers, whereby he exercised an important and beneficial influence, and contributed much to the completeness of the Exhibition. He was appointed, in connection with this undertaking, Special Commissioner in charge of the Department of the Juries, and at its close was made a Companion of the Bath and appointed to a position in the household of the Prince Consort. He was again given the Department of Juries in connection with the Exhibition of 1862, and had the appointment of the six hundred jurors; and in 1878 he was appointed chairman of the Finance Committee of the English Commission in the French Exhibition, under the presidency of the commission of the Prince of Wales. When the Department of Science and Art was established in 1853, he was appointed joint secretary with Mr. Henry Cole. Mr. Cole became secretary in 1856, and Dr. Playfair was made Inspector-General of Government Museums and Schools of Science. In 1857 he was elected President of the Chemical Society of London, and in 1858 was appointed Professor of Chemistry in the University of Edinburgh, where the Prince of Wales and Prince Alfred (now Duke of Edinburgh) enjoyed the privilege of his instructions.

He has served his country under official commissions, both in matters of scientific inquiry and in matters directly connected with political administration and legislation. Of the former classes of service may be mentioned his work in examining, in conjunction with Sir Henry de la Beche, into the suitableness of the coals of the United Kingdom for the purposes of the navy, his investigations into the causes of accidents in mines, and his services in the Royal Commissions on the Cattle Plague and on the Fisheries of the Scottish Coasts. The final outcome of the work of the last-named commission was the withdrawal of legislative restrictions on sea-fisheries. More intimately connected with politics, but still positions in which science has a part to perform, are or have been his positions as a member of Parliament, to which he was elected as a Liberal, in 1868, to represent the Universities of Edinburgh and St. Andrews; as Postmaster-General, to which he was appointed by Mr. Gladstone in 1873, and into which department "Nature" at the time expressed the hope that he would "endeavor to introduce something like scientific method"; as Privy-Councilor; and as chairman of the Committee of Ways and Means and Deputy Speaker of the House of Commons. Of a character partly allied to scientific or, at least, educational work and partly with politics, and pre-eminently tributary to the public good and to scientific methods of administration was his work as President of the Civil-Service Inquiry Commission of 1874, which resulted in the production of the elaborate scheme for the reorganization of the civil service, under the operation of which the British departmental administration has attained its present condition of high integrity and efficiency.

Pertinently to Sir Lyon Playfair's work in these lines, Lord Rayleigh, ex-president, said, in presenting him as its presiding officer to the Association at Aberdeen: "As a general rule, I should think that the desertion of active scientific work for politics was a step in the wrong direction; but, when one considers the valuable work done by Sir Lyon Playfair, the lucid manner in which he teaches our rather uninstructive legislators, the great influence he commands, and the valuable services he has rendered on many occasions, I feel that there are exceptions to the rule."

Professor Playfair's efforts have been unceasingly directed to promoting the improvement of the standards of education, and the adoption of more thorough and practical methods and objects in the teaching of the elementary and higher schools. Presiding at a meeting of a school-teachers' association in 1875, he referred to the subject of compulsory education, which was gradually becoming universal in the country, but which, he said, would be pure tyranny unless the education in the schools was increased and its quality raised. Quantity was all very good, but, unless quality accompanied it, there was not much gained. "If it was to be said that children of thirteen or fourteen years of age were merely to receive the same education as children of eight years of age, compulsory education would be but tyranny. Therefore, compulsory education involved higher education."

Of the direction toward which that increased and higher education should be pointed he made a clear and forcible statement in his address before the Educational Section of the Social Science Congress at Newcastle in 1870, when, having remarked that, "under our present system of elementary teaching, no knowledge whatever bearing on the life-work of the people reaches them by our system of state education," and that "the mere tools of education are put into the hands of children during their school-time without any effort being made to teach them to use the tools for any profitable purpose whatever, so they get rusty or are thrown away altogether," he unfolded his own views of the methods that should be pursued. "Books," he said, "ought only to be accessories, not principals. The pupil must be brought in face of the facts through experiment and demonstration. He should pull the plant to pieces and see how it is constructed. He must vex the electric cylinder till it yields him its sparks. He must apply with his own hand the magnet to the needle. He must see water broken up into its constituent parts, and witness the violence with which its elements unite. Unless he is brought into actual contact with the facts, and taught to observe and bring them into relation with the science evolved from them, it were better that instruction in science should be left alone, for one of the first lessons he must learn from science is not to trust in authority, but to demand proof for each asseveration. . . . Such education," he added, "cannot be begun too early. The whole yearnings of a child are for the natural phenomena around, until they are smothered by the ignorance of the parent. He is a young Linnæus, roaming over the fields in search of flowers. He is a young conchologist or mineralogist, gathering shells or pebbles on the sea-shore. He is an ornithologist, and goes bird-nesting; an ichthyologist, and catches fish. Glorious education in nature all this, if the teacher knew how to direct and utilize it. . . . Do not suppose that I wish the primary school to be a lecture-theatre for all or any of the 'ologies.' All the science which would be necessary to give a boy a taste of the principles involved in his calling, and an incitement to pursue them in his future life, might be given in illustration of other subjects. . . . I deny that the utilitarian view of primary education is ignoble. The present system is truly ignoble, for it sends the working-man into the world in gross ignorance of everything he is to do in it. The utilitarian system is noble, in so far as it treats him as an intelligent being, who ought to understand the nature of his occupation and the principles involved in it. The great advantage of directing education toward the pursuits and occupations of the people, instead of wasting it on dismal verbalism, is that, while it elevates the individual, it at the same time gives security for the future prosperity of the nation."

In another address, delivered a few days afterward, he spoke of the "Inosculation of the Arts and Sciences," or how they mutually grow out of and build up one another, and of the intimate union between science and labor. "It is not science," he said, "which creates labor or the industries flowing from it. On the contrary, science is the progeny of the industrial arts on the one side, and on the other of the experiences and perceptions which gradually attach themselves to these arts, so that the evolution of science from the arts is the first circumstance of human progress, which, however, quickly receives development and impulse from the science thus evolved. Industrial Labor, then, is one of the parents, and Science the child; but, as often happens in the world, the son becomes richer than the father, and raises his position. . . . Science does not depend upon facts alone, but upon the increase of mental conceptions which can be brought to bear upon them; these conceptions increase as slowly as the common knowledge derived from experience—they both descend by inheritance from one generation to another, until science in its progress becomes a prevision of new knowledge by light reflected from the accumulated common knowledge of the past. In the progress of time common knowledge passes into scientific knowledge." An indication of one of the ways in which he would have this system put into operation is given in a letter he wrote to the officers of a London school suggesting the devotion of a certain property to the formation of chemical and scientific museums in relation to commerce. No boy enjoying the advantages of such a museum "need leave the upper classes of the school without being able to examine the various kinds of merchandise which he will meet with in his occupations, so far, at least, as would enable him to test chemically their relative excellences, or detect their adulterations. No boy need then leave the school without having had his physical and political geography copiously illustrated by objects of natural history, in their relation to the imports and exports, upon which the prosperity of the country so largely depends."

Professor Playfair is a member of numerous scientific and other societies, British and foreign, and of several foreign orders. Of his literary work, Lord Rayleigh remarked in introducing him to the British Association: "The other day, engaged in some work of my own, I happened to look up the catalogue of science papers issued by the Royal Society, and I came across the list of Sir Lyon Playfair's early contributions to science, most of them made before I was born or thought of. One was on the new fatty acid in the butter of nutmeg. Another was 'Lectures on the Application of Physiology to the Rearing and Feeding of Cattle.' A third was on nitro-prussids, a new class of salts; and a fourth on 'The Study of Abstract Science essential to the Progress of Industry.'" He edited, conjointly with W. Gregory, Baron Liebig's "Chemistry in its Applications to Agriculture and Physiology." Besides numerous scientific memoirs, he has published, on general subjects, "Science in its Relations to Labor," a speech delivered on the anniversary of the People's College at Sheffield, in 1853; "The Food of Man in Relation to his Useful Work," a lecture, 1865; "On Primary and Technical Education," two lectures, 1870; "On Teaching Universities and Examining Boards," an address to the Philosophical Institution of Edinburgh, 1872; "Universities in their Relation to Professional Education," an address to the St. Andrews Graduates' Association, 1873; and "The Progress of Sanitary Reform," an address delivered at the annual meeting of the Social Science Association at Glasgow, 1874.

EDITOR'S TABLE.

MENTAL PROGRESS AND CULTURE.

WE have frequently maintained in these columns that a new type of culture is arising in modern times, which is not only strongly contrasted with the old ideal, but is, in essential respects, superior to it. This superiority is an inevitable result of the general laws of mental development by which successive ages become familiar with new orders of ideas. The progress of science is undoubtedly too much looked upon as having to do with the physical world only, as affecting useful arts, inventions, industrial processes, and the accumulation of wealth, but as leaving all the higher and nobler interests of mankind untouched. This is a narrow and erroneous view—the view of those who really do not know what science is accomplishing, nor how far-reaching and all-pervasive its results are destined to be. For it is one of the transcendent victories of science to have shown that the universe is bound together in all its parts by the most vital connections and a supreme unity, which make it impossible that there should be any great revelation respecting its fundamental order that does not throw light through all its departments. It may seem to certain minds a matter of no great moment that the physical and material sciences have come into existence, as they are assumed by such minds to belong to a lower sphere or grade of being, "the mere material," and to leave unaffected the loftier sphere of human nature, represented by the spiritual life. But this partial and partisan view must disappear when it is thoroughly realized that science itself belongs to this higher sphere, and that man is exalted by it through the acquisition of new truth and of grander ideas than he had before science appeared. The progress of science is a progress of thought, and the new and greater ideas thus acquired are certain to become the new instruments of a new culture.

This view was pointedly presented by Professor Cooke, of Harvard College, in his recent book on "Scientific Culture," in the following words: "What is it that ennobles literary culture but the great minds which, through this culture, have honored the nations to which they belong? The culture we have chosen is capable ot even greater things; not because science is nobler than art, for both are equally noble—it is the thought, the conception, which ennobles, and I care not whether it be attained through one kind of exercise or another—but we are capable of grander and nobler thoughts than Plato, Cicero, Shakespeare, or Newton, because we live in a later period of the world's history, when through science the world has become richer in great ideas. It is, I repeat, the great thought which ennobles, and it ennobles because it raises to a higher plane that which is immortal in our manhood."

It is no longer possible to deny that science as the latest is also the highest and most perfect product of the mind of man. We can no more ignore or discredit the mental growth of the race than the mental growth of the individual, and in neither case can childhood or youth yield the results of maturity. The literary ideal of culture, which embodies itself chiefly in the various arts of expression, was realized early and in the immaturity of human thought. Rude science, of course, also began early, but it did not become a method of cultivating the mind until thousands of years had passed. The work of science, as we now know it, is far too difficult and too grand to have been accomplished in the early or middle stages of human development. It now represents profounder study, more intense intellectual exertion, and a higher discipline of the mental faculties than was possible until mankind had had a long and painful experience in the difficult task of explaining the mysteries of Nature. By the necessities of the law of unfolding, therefore, the higher exploits of modern thought are not to be limited and measured by ancient standards. The ideal of literary culture belongs to an older and, consequently, to a lower stage of progress, and it can not continue to hold in this age the unrivaled ascendency which has been accorded to it in the past. Science represents an independent movement of the human mind, and creates standards of its own. It can not be judged, and is not to be ranked, by those who have been cultivated in a totally different order of ideas. To the linguists, as such, and to the cultivators of literature, as such, the understanding of the course of Nature is nothing. They could go on forever with their elegant arts in utter ignorance of it, and without missing it. The study of Nature, in a methodical way, was a new mental dispensation. The quest of truth by the methods that yield the truth, and because of the value of truth, was a new ideal, and the preparation for it a new education. Under the old ideal of culture truth was, in fact, disavowed as a supreme intellectual aim. The philosophers loved to seek it, but proclaimed that they did not care to find it; and there are still an emptiness, a hollowness, and a conventionality in the ideal of literary and scholastic culture, which betray its mediæval origin. With the coming of science as a method of thought, there came a profounder seriousness in the purposes of study, which could never have been originated in the purely literary sphere. With the coming of science, the thinker was forced to take a new relation to the world in which he lived. He became a devotee of truth in a sense not before known, and subjected himself to a moral as well as to an intellectual discipline, of which little could be understood in the earlier stages of mental cultivation.

The literary ideal of culture is still practically supreme. It is historic, it is fortified by institutions, it reigns in education, it is a social passport, it is suited for display, and makes a minimum requisition of intellectual effort. For these reasons it is popular, and we need not wonder at the arrogance and exclusiveness of its pretensions. But it belongs to the past, is losing its hold upon the present; and, while it may never be superseded, it is yet bound to be subordinated in future to that ideal of mental culture which is the highest intellectual attainment of the latest time, and which is to be perfected through the light of that scientific knowledge into which the human mind has emerged in this wonderful period. The triumphs of intellect in the conquest of Nature and the acquisition of great ideas in the understanding of the universe are not to be without powerful influence in determining the cultivation of the educated classes. The emancipation from narrow and groveling traditions may take place slowly, but the change is going on, and must go on, by the law of progress, until the newer and nobler knowledges become the highest instruments of mental cultivation.

A CATHOLIC ON CATHOLIC BLUNDERS.

Mr. St. George Mivart, the eminent naturalist, who is well known as an earnest member of the Roman Catholic Church, discusses in a recent number of the "Nineteenth Century" the question as to the degree of liberty which modern Catholics may claim in the treatment of scientific subjects. His conclusion is that their liberty in the matter is practically unbounded. The reason he gives will seem to some a little singular, and may possibly cause more or less wincing in certain quarters; but Mr. Mivart urges it with great confidence and apparently with great sincerity. Briefly stated, it is this: that the highest authorities of the Church were so egregiously, so ostentatiously, and so gratuitously wrong in the matter of Galileo and the earth's motion round the sun, that no absolute authority can ever attach to similar denunciations of scientific doctrines in future. Mr. Mivart brushes aside the reasonings by which it has been attempted to show that Galileo's condemnation was not formal. He insists that it was as formal and emphatic as it was in the power of the spiritual authorities of that day to make it; and yet, for all that, the persecuted man of science was in the right and his ecclesiastical judges were in the wrong. He says that it was a most fortunate blunder that they committed, seeing that it sets Catholics free for evermore to think for themselves upon all scientific matters, without exception or reserve of any kind. As we remarked above, some may not quite like the manner in which Mr. Mivart sets about proving his thesis; but his argument would be a difficult one to controvert. Authorities who have once blundered about as badly as it has ever been given to human beings to blunder, can hardly come forward again as supreme arbiters in a question of science; and, should they so come forward, even loyal sons of the Church might decline to submit to their decisions.

Mr. Mivart refers to an article contributed by an eminent Catholic theologian, Dr. Barry, about a year ago, to the "Dublin Review." On turning to it, we find the reverend doctor, to our great satisfaction, recognizing in the amplest manner the pre-eminent position occupied by science in the modern world, and claiming the largest degree of liberty for the scientific investigator. "Facts," he observes, "are as unassailable in their way as first principles; nor can the exigencies of reality be set aside, unless we would give the men of physical science leave to disown the necessities of thought?" He quotes "a metaphysician of high authority at Rome, Father Palmieri," as remarking that "one of the greatest calamities of the last three centuries has been the neglect of the study of physical science by orthodox Christians." It is needless to say that we find ourselves heartily in accord with the reverend father in this declaration. Had there been more study of physical science among orthodox Christians during the last three centuries, the cholera would not have carried off eighty thousand persons in Spain this year, nor would the comparatively small city of Montreal in Canada have had to bury small-pox victims this summer at the rate of two hundred a week. The reverend father holds that the Church is now reaping the reward of its disdain of science, in its loss of influence over large classes that once were embraced in its obedience. All this, Dr. Barry says, must be remedied. "Science is the common ground" on which the Church can meet its adversaries, and there it must meet them. "It is our duty to proclaim that we are not afraid of any argument or any assemblage of facts; but that we insist on giving its weight to every part of the evidence." Of course, the learned doctor, like the valiant fighter that he seems to be, hopes to overcome his adversaries. With that we are not concerned: what we note with pleasure is, that such strong ground should be taken up by eminent theologians of the most conservative communion in Christendom, in favor of a bold and thorough exploration of the scientific field. In so far as they approach modern scientific theories in a critical spirit, they will do only good, and may, if they come with the requisite preparation, do a great deal of good. Neither Science nor Philosophy has yet spoken its last word; and all true men of science will be thankful for any help they may get toward throwing aside their errors and rising to fuller and clearer perceptions of the truth.

DR. PLAYFAIR ON STATE SCIENCE.

We print the first portion of Sir Lyon Playfair's recent inaugural address as President of the British Association. It is unconscionably long, so that we must postpone to next month his concluding sections on "Science and Industry," and "Abstract Science the Condition of Progress." Sir Lyon follows the precedents of his predecessors in discussing what he knows most about, for he is probably the most prominent and experienced scientific office-holder and engineer of state science generally that is to be found in the British Empire. He was early taken into the royal family, and has ever since been on intimate relations with those upper classes which constitute the governing power of England, and this fact is not without its bearing on his discussion of "Science and Secondary Education."

Of course, he is driven upon the question of science and the classics, and must recognize, as does all the world, that science is scandalously neglected in leading British schools, while excessive attention is given to classical studies. This educational issue in England is intricately involved with the English social system. Classics and science is a question of classes: science is for the lower classes, classics for the higher classes. A succession of parliamentary commissions has deplored the neglect of science in the great endowed schools, but with very little effect. The Duke of Devonshire was compelled to report, in 1873, "considering the increasing importance of science to the material interests of the country, we can not but regard its almost total exclusion from the training of the upper and middle classes as little less than a national misfortune." But why should the middle-class schools be here ranked with the upper-class schools? Because they imitate them. Dr. Playfair says, "Unfortunately, the other grammar-schools which educate the middle classes look to the higher public schools as a type to which they should conform." But the upper-class schools are places where science is despised and the classics worshiped. Sir Lyon Playfair, although professedly representing science, is not the man to condemn a settled upper-class English policy. He virtually gives up the contest in saying, "The great public schools of England will continue to be the gymnasia for the upper classes, and should devote much of their time to classical and literary culture." What is this but yielding everything, and reducing the whole movement for a higher scientific education to a farce? If classics are the superior mental pabulum of aristocrats and gentlemen, and science only suited for plebeians, then is the English resistance to scientific education right, as it would be a degradation and a step backward toward barbarism. The affiliations of classics and aristocracy are old and intimate, and still profoundly cherished in countries like England and Germany; but when eminent scientists like Hoffman and Playfair avail themselves of great occasions to indorse them to the damage of science, we say, deliver us from our nominal friends.

LITERARY NOTICES.

Modern Science and Modern Thought. By S. Laing, Esq., M. P. London: Chapman & Hall; Philadelphia: Lippincott. Pp. 320. Price, $4.

Both the plan of this book and the manner of its execution will give it a strong claim upon many readers. The first six chapters, comprising more than half the volume, are devoted to summing up the large results of modern science, in so far as they have given rise to new views of nature and the universe. The first chapter, under the title of "Space," states the striking facts that have been disclosed in later times concerning the magnitude and order of celestial phenomena. It tells of the revolution of human ideas, on a great scale, which has been wrought by astronomy. Chapter II takes up the conception of "Time," as disclosed in the revelations of modern geology, and the grand course of changes that have been brought about in vast periods, with a summary of its vital bearings on man's conception of the world. In the next chapter, under the title "Matter," an account is given of the constitution of nature in its physical and chemical elements, as shown by the spectroscope and illustrated by the universal law of the conservation of energy and the views that have been arrived at concerning the birth and death of worlds. Mr. Laing then gives a chapter to the subject of "Life," which is descriptive of the views now entertained of its course of development upon earth, and the biological laws which have been established in recent times. He next takes up the subject of the "Antiquity of Man," and gives a very clear statement of the evidence, from which it is inferred that the human race is far older than was formerly supposed. This subject is pursued still further in Chapter VII, on "Man's Place in Nature." The doctrine of evolution is broadly assumed, and man and civilization are treated as its products. In this first portion of his work Mr. Laing undertakes no more than to give a popular statement of the great facts and theories on these several subjects, which we owe to science, with no attempt to propound views of his own. His work is excellently done. The presentation is kept in due proportion, is trustworthy, and is very clearly and instructively written. We know of no other so valuable a summary of what science has accomplished in subverting old opinions, and substituting a new and higher order of knowledge.

Part II is devoted to "Modern Thought," and here the author takes independent ground, and, ceasing to follow authority, becomes responsible for his own opinions. His object now is to trace the consequences of those great revolutions of ideas which we owe to science, as they affect philosophical and religious opinion and current conceptions of common and practical life. He maintains that the great body of traditional thought has been variously but profoundly disturbed by modern scientific enlightenment. Especially are old creeds and philosophies undermined and shattered by scientific progress, and "the endeavor to show how much of religion can be saved from the shipwreck of theology has been the main object of the second part" of this work. Supernaturalism is rejected without reservation, and it is elaborately argued that Christian miracles have no better support than the alleged miracles of other religious systems. It is the view of the author that, only as the deeply implanted errors of superstition are eradicated, will it be possible to gain the great advantages to mankind which must ultimately come from the immense modern extensions of scientific truth. Mr. Laing handles these topics with entire freedom, but with great sincerity, and closes his preface by remarking, "I can only say that I have endeavored to treat these subjects in a reverential spirit, and that the conclusions arrived at are the result of a conscientious and dispassionate endeavor to arrive at 'the truth, the whole truth, and nothing but the truth.'"

Prehistoric Fishing in Europe and North America. By Charles Rau. Washington: The Smithsonian Institution. Pp. 342.

In the *débris* left by the cave-men of Europe are found small bone implements, pointed at both ends, whose use can not be definitely stated. The Indians of Washington Territory use similar implements for catching fish and birds by tying a line round the middle and baiting them, and this fact suggests that the European implements may have been used as bait-holders in like manner. Other relics of the palæolithic fishermen described by Dr. Rau are barbed harpoon-heads of reindeer-horn and pieces of horn and bone, bearing scratches which, with more or less effort, can be accepted as designed to represent fish and fishing scenes. To the neolithic period belong the relics of the Swiss lake-villages. Among them are fish-hooks and harpoon-heads of bone and horn, fragments of nets, and certain perforated stone disks, which may have served as line or net sinkers. Similar implements have been found at other places in Europe. Fish-hooks of bronze also have been found on the sites of the lake-villages. Dr. Rau gives figures of about thirty bronze hooks. They vary much in form and size; a part only are barbed, but nearly all are bent over at the top to form an eye for the attachment of the line.

The second part of the memoir treats of American aboriginal fishing, and is based on the materials contained in the archæological division of the National Museum, of which division Dr. Rau has charge. Some of the hooks of aboriginal manufacture are similar in general form to ordinary modern fish-hooks, but only one regularly barbed specimen is known to the author. It was found in Madison County, New York, and is thought to have been made since 1600, and in imitation of the hooks brought to this country by Europeans. The hooks of bone and shell found in California are peculiar. The curved point approaches so closely to the shank that some persons have doubted their ever being used as fishing implements. It would probably be impossible to *hook* fish with hooks of this shape, but just such hooks have been brought from Pacific islands by travelers, who report that the natives are very successful with them in taking fish that bolt the hook instead of nibbling at it. No bait is used, as the hook itself looks somewhat like a worm. Twenty-eight dart-heads of bone and horn are here figured, most of which the author believes were armatures for fishing implements. Twenty of them have barbs on one side only, while the others are barbed on both sides. Several dart-heads of copper, each of which has a single barb, are in the collection of the State Historical Society of Wisconsin. A large number of grooved, notched, or perforated stones have been found, which must have been used as sinkers for fish-lines and nets. Similar stones aro used as sinkers by both Indian and white fishermen to-day. Two specimens of copper sinkers have come within the knowledge of the author. Stone carvings and pottery representing fishes have also been found in this country. The evidence that the American aborigines used mollusks as food is abundant; great heaps of oyster, clam, mussel, and other shells are found along our sea-coasts and river-banks. Intermingled with these shells are bones of various animals, implements, fragments of pottery, and vestiges of fireplaces. Dr. Rau appends to this memoir fifty-eight pages of extracts from various writings of the last four centuries, in which reference is made to aboriginal fishing in North America, and some notices of fishing implements and fish representations discovered south of Mexico. The text is illustrated by four hundred and five figures.

Town Geology: The Lesson of the Philadelphia Rocks. Studies of Nature along the Highways and among the Byways of a Metropolitan Town. By Angelo Heilprin, Professor of Invertebrate Paleontology at, and Curator-in-charge of, the Academy of Natural Sciences of Philadelphia. Philadelphia: Published by the Author. Academy of Natural Sciences, 1885. Pp. 152, with Seven Plates.

Not only from the simple to the complex, and from the concrete to the abstract, but from the immediate to the remote, lie the true directions of mental movement in the growth of knowledge and in rational study. To begin where there is much familiarity, some knowledge, and more or less curiosity and interest, and pass on to that which is remoter and deeper, is the true method. But, strange to say, the reverse method is that usually pursued. Instead of starting with the known and building upon it, the custom is to begin with the distant and unknown, and often, indeed, stay there so long that the knowledge acquired in many cases never becomes a reality at all. Geology, particularly, is liable to be pursued in this way, general ideas being accumulated from the books, with little application to facts within the limit of common experience.

The present volume is an admirable exemplification of the true method of geological study. The author takes up the facts with which all Philadelphians are familiar, and in which they may be therefore assumed to have a certain degree of interest, and connects them in a very simple and instructive way with the great body of geological truths in which these facts find their explanation. The rock systems in the Philadelphia neighborhood are described, together with the changes which have led to the present condition of things, and the accompanying succession of life as disclosed by fossil relics. "White-Marble Steps and Window-facings," "Brown-stone Fronts and Jersey Mud," "Philadelphia Brick and Cobblestone," are the familiar texts used by the author to interpret the wonderful workings of Nature in the immeasurable past, and which, through long chains of causes and effects, have given rise to the present order of things. The work is admirably done, and the studious citizens of the Quaker metropolis owe their best thanks to the young geologist who has performed the task. It would be a good thing if we could have something of the kind in New York.

Proceedings and Transactions of the Royal Society of Canada, 1884. Montreal: Dawson Brothers.

This second volume, issued by the Royal Society of Canada, comes to us with its united departments of literature and science, in French or English, as the language of the contributor may be. Of the scientific memoirs only need we here speak; they are varied and excellent. Dr. George Lawson, Professor of Botany at Dalhousie College, Halifax, Nova Scotia, gives a revision of the Canadian *Ranunculaceæ*, in confirmation and extension of a monograph published in 1870. During fifteen years he has given direction to the observation of this important order by botanists afield throughout the wide provinces and territories of the Dominion. Direction of this kind gives value to much of what might otherwise be but disconnected observation. Dr. Lawson's memoir, though extensive, is incomplete in certain groups to which he directs the attention of Canadian botanists.

Dr. T. Sterry Hunt, of Montreal, president of the society, presents a review of the much controverted Taconic question in geology, and shows ground for believing that the newest member of the great series of pre-Cambrian, crystalline, stratified rocks is what is called Lower Taconic, or Taconian, and is widely distributed over North and South America, Europe, and Asia. Dr. Hunt has arrived at his conclusions from protracted study in America and Europe.

From the same eminent geologist we have a paper on the "Origin of Crystalline Rocks." He approaches the great problem of the origin of such rocks as granite and gneiss, and after a discussion of the Neptunian, igneous, and the metamorphic schools, rejects them all as untenable, in favor of what he calls the crenitic hypothesis, and claims it as a legitimate development of the Neptunism of Werner. This hypothesis supposes the existence of a primary Plutonic stratum, the outer layer of the original aqueous globe, which, more or less modified by the subsequent penetration of water, has been the direct source of eruptive rocks like basalt and dolerite, and at the same time has furnished indirectly and by aqueous solution the elements of all granitic and gneissic rocks. This radical and far-reaching hypothesis will doubtless command the attention of chemists and geologists the world over.

Other papers of interest, on topics chemical, zoölogical, and physical, evidence the activity of original research among men of science in Canada.

The Copper-bearing Rocks of Lake Superior. By Roland Duer Irving. Washington: Government Printing-Office. Pp. 464, with Twenty-nine Plates.

This is a paper prepared in connection with the United States Geological Survey under Mr. Clarence King. It aims at a general exposition of the nature, structure, and extent of the series of rocks in which occurs the native copper of Lake Superior; a work which has never been attempted before, nor, it is asserted, could it have been accomplished sooner. Much had been written on different parts of the Lake Superior basin, but gaps still existed in the surveys, and much remained to be learned concerning the nature of the crystalline rocks. These obstacles have been removed by the later surveys, and the gaps that still remained have been filled by the personal observations of Mr. Irving and his aids. All the information at command has been examined and drawn upon and is used, and the views of different authors, often conflicting, are discussed in the present work.

Contributions to the Knowledge of the Older Mesozoic Flora of Virginia. By William Morris Fontaine. Washington: Government Printing-Office. Pp. 144, with Fifty-seven Plates.

The Mesozoic beds of Virginia are all situated east of the Blue Ridge, and most of them are found within the terrain of the crystalline Azoic rocks. The beds are divided into two classes, which appear to have but little in common with one another. The older Mesozoic beds, which furnished the plants described in this book, are of fresh-water or brackish-water deposit, and often contain coals. The younger formations also contain plants, but of a totally different character from that of the plants of the older Mesozoic. The most important of all the beds passes about ten miles west of Richmond, and is about thirty miles long and six broad. It contains nearly all the coal and yields nearly all the plants found in the formation. Besides the plants found in these beds, and for the sake of comparison with them, plates and descriptions are given from Emmons's work of plants from the older Mesozoic strata of North Carolina, most of which, however, coming from strata above the coal, are supposed to be of a somewhat later age than the Virginia plants.

The Q. P. Index for 1884. Fourth annual issue. Bangor: Q. P. Index. Pp. 57. Price, $1.

In this issue, which forms No. 17 of the Q. P. series, the numbers for 1884 of fifty periodicals, and of the United States consular reports and education circulars, are indexed. The list includes all the important American literary magazines and reviews, most of the British literary magazines which have a circulation in this country, and about a dozen German periodicals. The "Revue de Belgique" is included, but not the "Revue des Deux Mondes." Since the British reviews were indexed in No. 16, they do not appear in this issue. When one realizes that about seventy-five thousand pages are indexed in these fifty-seven pages, it becomes evident that Mr. Griswold has brought the art of abbreviating to a wonderful state of efficiency. He is also a spelling reformer who has the courage of his convictions, for he writes "forein," "welth," "tarif," "primitiv," "fotografy," "iland," etc.

Commercial Organic Analysis. By Alfred H. Allen, F. I. C., F. C. S. Second edition, revised and enlarged. Vol. I. Philadelphia: P. Blakiston, Son & Co. Pp. 476. Price, $4.50.

The edition of this work now publishing is to appear in three volumes instead of two, as in the first edition. A new arrangement of the subject-matter has been adopted, so that each volume may treat more especially of kindred products. The volume now presented is devoted chiefly to the consideration of bodies of the fatty series and of vegetable origin, and includes chapters on the alcohols, ethers, and other neutral derivatives of the alcohols, sugars, starch and its isomers, and vegetable acids. In revising this volume, the author has made considerable changes and additions in order to bring the information contained up to the latest possible date, so that very few pages remain as they stood in the first edition. He promises as thorough treatment of the rest of the work.

Insomnia; and other Disorders of Sleep. By Henry M. Lyman, M. D. Chicago: W. T. Keener. Pp. 239. Price, $1.50.

This book discusses in a clear and readable style one of the severest afflictions to which man is liable. In the discussion the author covers an even wider ground than is indicated in his title, and considers all the phenomena of sleep, both normal and troubled. He begins with a full chapter on "The Nature and Cause of Sleep," which is followed by the consideration of the immediate subject of the treatise—insomnia, or wakefulness, the remedies for it and the treatment of it in particular diseases; and after this are given chapters on "Dreams," "Somnambulism," and "Artificial Somnambulism, or Hypnotism."

List of Tests (Reagents). By Hans M. Wilder. New York: P. W. Bedford. Pp. 88. Price, $1.

The nine hundred and fifty-three tests are described briefly under the names of the originators, which are arranged alphabetically, and a subject-index is added. The very common tests are not included.

Descriptive America. A Geographical and Industrial Monthly Magazine; L. P. Brockett, Editor. Pp. 32. Price, $5 a year; 50 cents a number.

Each number of this publication is devoted to a particular State. The number before us, which is marked Vol. I, No. 6, is given to Georgia. It includes a fine map of the State, a list of cities, towns, villages, and stations, an editorial article on international exhibitions, and chapters describing the State in general and relating to cotton and rice culture, lands, population, immigration, education, the representative men, the religious condition, government, finances, debt, and taxation and history of the State, with a statistical table of counties. Several of these articles are furnished by men disl tinguished or representative in the speciafields to which the papers respectively relate.

Van Nostrand's Science Series. New York: D. Van Nostrand. Price, 50 cents each.

No. 73. Symbolic Algebra; or, The Algebra of Algebraic Numbers. By Professor William Cain. Pp. 131. The object of this essay is the discussion of negative quantities of algebra, with the purpose of finding a logically developed system that shall include such quantities as special cases. The volume also includes some critical notes on the methods of reasoning employed in geometry.

No. 74. Testing-Machines: Their History, Construction, and Use. By Arthur V. Abbott. Pp. 190. Mr. Abbott has been engaged for several years in developing and applying methods of testing the strength of materials, and in this book explains such of his most successful methods as seem likely to be generally useful and interesting.

No. 75. Recent Progress in Dynamo-Electric Machines. By Professor Silvanus P. Thompson. Pp. 113. This is a reprint of lectures delivered before the English Society of Arts on the subject indicated in the title, which were supplementary to a previous series of lectures on the theory of the dynamo and its functions as a mechanical motor.

No. 77. Stadia-Surveying. By Arthur Winslow. Pp. 148. This hand-book contains a complete exposition of the theory of stadia measurements, with directions for its application in the field. Tables for the reduction of observations are added which the author has used in the Geological Survey of Pennsylvania, and with them the trigonometrical four-place tables.

No. 78. The Steam-Engine Indicator. By William Barnet Le Van. Pp. 169. In this book the indicator and its object are described; its construction and action are explained; and the method of calculating the horse-power of engines is illustrated. An endeavor has also been made to explain the most important parts of the theory and action of steam, and to show the modes of working engines that have been found to be most advantageous.

No. 79. The Figure of the Earth. By Frank C. Roberts, C. E. Pp. 95. In this book the historical data in connection with the figure of the earth are presented, and the important mathematical principles for the deduction of it upon the spheroidal hypothesis are arranged in a compact form.

No. 80. Healthy Foundations for Houses. By Glenn Brown. Pp. 143. This is a reprint of a serial paper published in the "Sanitary Engineer" during 1884, with fifty one illustrations from drawings made for the articles by the author.

Maps of the Dominion of Canada. Telegraph and Signal Service. Sir Hector L. Langevin, Minister of Public Works. In sheets.

These maps are intended to be full, and are very handsomely executed. The group now under notice contains two sheets of the Eastern section, two of the West-Central section, two of the Western or Pacific coast section, with a Mercator chart of telegraphic lines and electric-cable connections throughout the world; and a map on a spherical projection showing the world's submarine cables and principal telegraph lines.

Notes from the Physiological Laboratory of the University of Pennsylvania. Edited by N. A. Randolph and Samuel G. Dixon. Philadelphia. Pp. 88.

A collection of "brief records of facts of interest brought to light in the course of physiological study." The constant aim of the writers has been to present these facts with the greatest conciseness compatible with scientific accuracy.

N. W. Ayer & Son's American Newspaper Annual, 1885. Philadelphia: N. W. Ayer & Son. Pp. 750. Price, $3.

The publishers have taken great pains to make this work complete and correct up to the day of going to press. It contains a fully descriptive list of newspapers and periodicals in the United States and Canada, arranged by States in geographical sections, and by towns in alphabetical order; another list, descriptive as to distinctive features and circulation, of newspapers inserting advertisements, arranged in States by counties; a third list, of class and professional publications, and publications in foreign languages. From these lists may also be obtained other information about newspapers; and in connection with them there is given a description, with statistical information, accounts of manufacturing enterprises, and political notes, respecting each county. Finally, the book contains an alphabetical list of cities, towns, and villages in the United States having a population of five thousand and upward.

How to drain a House: Practical Information for Householders. By George E. Waring, Jr., M. Inst. C. E. New York: Henry Holt & Co. Pp. 222, with Twenty Illustrations. Price, $1.25.

Colonel Waring has given long and attentive study to the matter of house-drainage, and as a result he has views of his own upon the subject which will be found stated in the present volume. Not by any means that the book has been written merely to promulgate his own notions; it has been prepared because, in the author's opinion, it will prove the best and safest guide in a field of practice of vital importance, and still far from settled in its methods. The author holds that there has been unquestionably a steady improvement in recent years in dealing with the difficult problems of the disposal of household waste; each step, however imperfect in itself, being better than the condition of things which preceded it. Such, indeed, have been the progress made and the success achieved as greatly to strengthen the expectation that an ideally perfect system of house-drainage may soon become an accomplished and accepted fact. Meantime improvement is along various lines of trial, with a certain inevitable rivalship of views and devices. Colonel Waring does not, however, in the present volume attempt to give an account of the various ideas and contrivances, however excellent they may be, that have now come into use; but having studied them all, and had large experience of the subject, he has fixed upon his own methods, and devotes his work to an exposition of them.

We have read the book carefully through, and have found it unusually interesting and instructive. The preliminary remarks on house-drainage and health are impressive and decisive, and the explanation of principles and the description of plans and construction are full, clear, and perfectly intelligible. The book abounds in common-sense suggestions, and is certain to prove valuable to all house-constructors and housekeepers who are seeking correct information upon the subject.

Ballooning: A Concise Sketch of its History and Principles. By G. May. New York: D. Van Nostrand. Pp. 96, with One Plate.

The author believes that, though practical aërial navigation has so far been found unattainable, the pursuit of it has resulted in something, though it be little, to facilitate art and scientific progress. In this work, besides reviewing the history of ballooning, he seeks to ascertain and define the obstacles which interfere with its active progress, the mechanical means necessary to surmount them, and the natural power by which those means are to be put in operation; and to point out certain regulations and restrictions by which they must be governed in their application.

The Lock-Jaw of Infants (*Trismus Nascentium*). Its History, Cause, Prevention, and Cure. By J. F. Hartigan, M. D. New York: Bermingham & Co. Pp. 123.

The disease in question is often fatal during the first month of infantile growth, but doctors have not been able to ascertain or agree upon its cause. The author maintains a theory which was advanced by Dr. J. Marion Sims some thirty years ago, but never received attention—that it is occasioned by mechanical pressure of the occipital or parietal bones on the brain.

Malthus and his Work. By James Bonar. London: Macmillan & Co. Pp. 432. Price, $4.

No author is more talked about, when questions of political economy or social science are under consideration, than Malthus; no dogma than what is called the Malthusian theory. But, according to the view of the author of this book, very few of those who have so much to say about the man and his doctrines know what they really are. "Malthus," he says, "was the best abused man of the age"; and the temper and abundance of the abuse that has been launched against him "amount to a demonstration" that his opponents are in the wrong, or that his logic is too sound for them. The points at issue were fully enough discussed in his own time between Malthus and his adversaries, "and no one who fairly considers the extent of the discussion, and the ability of the disputants, can fail to believe that we have, in the records of this controversy, ample materials for forming our own judgment on the whole question. . . . Such a privilege is seldom used. The world has no time to consult authorities, though it likes them to be within reach of consultation. When an author becomes an authority, he too often ceases to be read, and his doctrines, like current coin, are worn by use till they lose the clear image and superscription of the issuer. In this way an author's name may come to suggest, not his own book, but the current version of his doctrines," and this is seldom a wholly fair one. Such, Mr. Bonar seems to think, has been the case with Malthus; and the purpose of the present volume is to give an exact account of his life, his teachings, and the object and character of his book.

Annual Report of the Board of Regents of the Smithsonian Institution for 1883. Washington: Government Printing-Office. Pp. 959.

This report contains much valuable information concerning scientific work and progress in various departments in this and other countries. One of its excellent features is its running summaries of the progress of investigations carried on by the members of Government surveys and expeditions, and by private persons in correspondence with the Institution, which cover a wide ground. A full account is given of the inauguration of the statue of Professor Henry, with the memorial address of Chief-Justice Waite, the oration of President Noah Porter, and a representation of the statue. Among the special papers are the accounts of progress during the year in the several departments of science, and a number of accounts of explorations of mounds and other anthropological work.

Cholera: its Origin, History, Causation, Symptoms, Lesions, Prevention, and Treatment. By Alfred Stillé, M. D. Philadelphia: Lea Brothers & Co. Pp. 164.

The author has enjoyed the advantage of studying cholera in two epidemics, and has prepared this volume in view of the general newly awakened interest on the subject and the agitation of Dr. Koch's germ theory. While declining to accept the doctrine of Dr. Koch and his supporters as demonstrated, he seeks "to exhibit the specific nature of cholera by evidence drawn from its origin and mode of propagation; to disabuse the medical profession of the erroneous notion that the disease ever originates *de novo*; to maintain the necessity of quarantine, not in the literal but in the official sense of that word; to point out the channels through which cholera may be diffused; and to describe the measures which experience has sanctioned to prevent its dissemination and cure those who are attacked by it."

Silver-Lead Deposits of Eureka, Nevada. By Joseph Story Curtis. Washington: Government Printing-Office. Pp. 200.

From the year 1869 to 1883, Eureka district produced about $60,000,000 of gold and about 225,000 tons of lead. Owing to the fact that the deposits of this district have been more completely developed than any other of a similar character on the Pacific slope, they offer very full opportunities for the scientific investigation of formations of this class. The information on which this report is based was collected during field-work by the author in 1881 and 1882, and from the reports of Mr. George F. Becker's preliminary examination of the more important mines, and of Mr. Arnold Hague's survey of the geology of the district in 1880.

In the present report, Mr. Curtis gives a clear and systematically ordered description of the district, its geology, and the several mining locations, with their characteristic features. Among the topics particularly considered are the surface geology, the structure, and the ores of Prospect Mountain and Ruby Hill, the ore deposits, the source and manner of deposition of the ores, the occurrence of water in the mines, the methods of mining and timbering, and of working the ores, an account of Adams Hill, and "the future of the Eureka district." We are pleased to observe that Mr. Curtis's work in this field has elicited warm commendation and high testimonials to its value from foreign experts: Herr V. Groddeck, Director of the Clausthal School of Mines, Austria, having studied the report "with the greatest interest," has expressed his appreciation of "the instruction and suggestions contained in it," and adds: "It is always wonderfully pleasing to me to see with what intensity and with what rich results your country pursues the study of ore deposits." Herr F. Posepny, Inspector of Mines for Austria, who has visited Eureka, and has drawn some interesting comparisons between its features and those of some of the Hungarian mines, characterizes this work as one which "is destined to play an important part in the technical literature of ore deposits. When I glance over what I know from actual inspection, and what I know through the literature of the ore deposits of your country, I am more and more convinced that North America will be the coming school for the study of ore deposits." Herr Posepny adds that he is much interested in the results of Mr. Curtis's examination of country rock for minute quantities of metals, as the subject has been taken up in his own country from a practical stand-point.

Memoirs of the National Academy of Sciences. Vol. II., 1883. Washington: Government Printing Office. Pp. 262.

The present volume contains four memoirs, of which the most voluminous is the full account of the eclipse of the sun, of May, 1883, and of the United States Expedition to Caroline Island, in the South Pacific Ocean, to view it. Included in this memoir are several special papers of considerable general interest, among which are the narrative of the voyage to Caroline Island and return, the history and general description of the island, various scientific and technical memoranda respecting it, its botany, zoölogy, and butterflies; and particular reports of eclipse observations by eleven associates of the expedition. The whole is attractively illustrated with maps and views of the island and its peculiar scenery, and representations of various features of the eclipse. The second memoir is Professor S. P. Langley's paper on the "Experimental Determination of Wave-lengths in the Invisible Prismatic Spectrum"; the third is by Professor William H. Brewer, "On the Subsidence of Particles in Liquids"; and the fourth is the paper of Alexander Graham Bell "Upon the Formation of a Deaf Variety of the Human Race," of which we have already given a brief abstract.

Dinocerata. (United States Geological Survey, Vol. X.) By Othniel C. Marsh, in charge of the Division of Paleontology. Washington.

This monograph contains the full record of an extinct order of mammals, of which the author has made special studies. The only locality where remains of the Dinocerata have been found is an Eocene lake-basin in Wyoming, and there his first discoveries were made by Professor Marsh in 1870. The specimens collected in this and successive expeditions are now in the museum at Yale College, and represent more than two hundred individuals of the Dinocerata, besides the remains of many other vertebrata hitherto unknown. Seventy-five of these have portions of the skull preserved, and in more than twenty it is in good condition. Three genera have been established in this order: *Dinoceras*, Marsh; *Tinoceras*, Marsh; and *Uintatherium*, Leidy. The skull of *Dinoceras mirabile* is long and narrow; it supports on the top three pairs of bony elevations or horn-cores, which form its most conspicuous feature, and suggested the name of the genus (δεινός, *terrible*, and κέρας, *a horn*). There are no upper incisors; the canines in the male are enormously developed, forming sharp, trenchant, decurved tusks. The brain of the Dinocerata is sepecially remarkable for its diminutive size. From an extended comparison of the brain-cavities of Tertiary mammals, Professor Marsh has found that there was a gradual increase in the higher portion of the brain during this period, and that the brain of a mammal fitted for a long survival was proportionately larger than the average. The remains of *Tinoceras* are found in the same lake-basin, but at a higher level, and the evidence is clear that it was a later and more specialized form. *Tinoceras ingens*, as he stood in the flesh, was about six and a half feet in height to the top of the back, and about twelve feet long. His weight was probably at least six thousand pounds. *Dinoceras mirabile* was about one fifth smaller. In an appendix Professor Marsh gives a synopsis of Dinocerata, in which all the known species of the order, about thirty, are recognized, and a bibliography follows the synopsis. With the aim of making the illustrations tell the main story to anatomists, the author has incorporated in the volume fifty-six fine, large lithographic plates, and nearly two hundred original woodcuts, representing all the more important specimens of the Dinocerata now known, and including at least one figure of every species.

Paleontology of the Eureka District. By Charles Doolittle Walcott. Washington: Government Printing-Office. Pp. 298, with Twenty-four Plates.

In this report are presented the results of a careful survey of a district with a rich fauna, through thirty thousand feet of Palæozoic strata, representing the Cambrian, Silurian, Devonian, and Carboniferous rocks. It is regarded by Mr. Arnold Hague, geologist in charge of the district survey, as "the most important contribution yet made to the invertebrate paleontology of the basin ranges, and of great value in its bearings upon the geology of the Cordilleras."

The Manual of Phonography. By Benn Pitman and Jerome B. Howard. Cincinnati: Phonographic Institute. Pp 144.

This is a revised edition of the "Manual" by Benn Pitman, the first edition of which appeared in 1855. While a number of new features appear in its pages which were not in its predecessor, the plan of presenting the system is essentially the same. Such changes and additions to the system, and such only, as are of real importance have been adopted.

Chemical Problems. By Dr. Karl Stammer. Translated by W. S. Hoskinson. Philadelphia: P. Blakiston, Son & Co. Pp. 111. Price, 75 cents.

A list of questions on the properties of the elements, chemical phenomena, and manipulation, to be answered by the student through experiment or by calculation from what he knows. The answers are given in the latter part of the book.

The Students' Manual of Exercises for translating into German. By A. Lodeman. New York: G. P. Putnam's Sons. Pp. 87. Price, 50 cents.

The exercises in this volume have been prepared with the twofold purpose of furnishing to the student material for translating into German, and of assisting him in the analysis and translation of the more difficult illustrations in Brandt's "German Grammar," to which he is constantly referred. A full vocabulary, notes, references, and general suggestions are provided.

PUBLICATIONS RECEIVED.

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The Evolution of Revelation. By James Morris Whiton, Ph. D. New York: G. P. Putnam's Sons. Pp. 34. 25 cents.

Recitations and Readings. New York: J. S. Ogilvie & Co. Pp. 126. 10 cents.

Voice in Singers. By Carl H. von Klein, M. D., Dayton, Ohio. Pp. 8.

City Government. By Charles Reemelin. Cincinnati, Ohio. Pp. 15.

Canals and Railroads; Ship-Canals and Ship-Railways. Pp. 16. The Interoceanic Problem, and its Scientific Solution Pp. 40, with Six Plates. By Elmer L. Corthell.

The External Therapeutics of Pulmonary Consumption. By Thomas J. Mays, M. D. Philadelphia. Pp. 16.

Development of Crystallization; and Geology in the Washoe District. By Arnold Hague and Joseph H. P. Iddings. Washington: Government Printing-Office. Pp. 44.

A Great Trap-Dike across Southeastern Pennsylvania. By H. Carvill Lewis. Pp. 20, with Map.

Quarterly Report, Bureau of Statistics, Treasury Department, Second Quarter, 1885. Washington: Government Printing-Office. Pp. 175.

Massachusetts State Agricultural Experiment Station, Amherst. August Bulletin, 1875. Pp. 12.

The Raising and Management of Poultry. Report of Discussions of Breeders and Experts. Boston: Cupples, Upham & Co. Pp. 125. 50 cents.

Urethral Stricture treated by Electrolysis. One Hundred Cases. By Robert Newman, M. D. Pp. 15.

Woman's Medical College of the New York Infirmary. Seventeenth Annual Catalogue and Announcement. New York: G. P. Putnam's Sons. Pp. 25.

North American Species of Ramularia. Pp. 10. Cercosporæ of North America. Pp. 50. By J. B. Ellis and Benjamin M. Everhart, Manhattan, Kansas.

Parasitic Fungi of Illinois. By J. T. Burrill. Peoria, Ill.: J. W. Frank & Sons. Pp. 111.

Evolution in the Vegetable Kingdom. By Lester F. Ward. Pp. 16.

Coloration of Naked Skin-Tracts of Geococcyx Californicus. By Dr. R. W. Shufeldt. Pp. 2, with Plate.

The Metric System. By John Le Conte, Berkeley, Cal. Pp. 12.

Diseases of Farm Animals. Agricultural College of Michigan. Pp. 4.

"Journal of the American Akadêmê." Alexander Wilder, Editor. Monthly. Newark, N. J. Pp. 24. $2 a year.

New York Cancer Hospital. First Annual Report. Pp. 23.

Notes on the Stratigraphy of California. By George F. Becker. Washington: Government Printing-Office. Pp. 28.

University of Pennsylvania: Department of Biology, Catalogue and Announcement. Pp. 9.

Bulletin of the Sedalia (Mo.) Natural History Society. F. A. Sampson, Corresponding Secretary. Pp. 30.

The Shells of Pettis County, Missouri. By F. A. Sampson, Sedalia, Mo. Pp. 16.

Consanguineous Marriages: their Effect on Offspring. By Charles F. Withington, M. D. Roxbury, Mass. Pp. 32.

American Constitutions. By Horace Davis. Baltimore: N. Murray. Pp. 70. 50 cents.

On the Sensitiveness of the Eye to Colors of a Low Degree of Saturation. By Edward L. Nichols, Ph. D. Pp. 5.

The Teacher's Commercial Value. Pp. 20.

Teaching as a Business for Men. By C. W. Bardeen. Syracuse, N. Y.: C. W. Bardeen. Pp. 20.

The Relation of Annual Rings of Exogens to Age. By D. P. Penhallow. Pp. 16.

Impact Friction and Faulting. Pp. 29. The Relations of the Mineral Belts of the Pacific Slope to the Great Upheavals. Pp. 4. By George F. Becker. Washington, D. C.

Bulletin of the Minnesota Academy of Natural Sciences, 1880–1882. C. W. Hall, Secretary. Minneapolis. Pp. 80.

The Bentley-Knight Electric Railway Company, 115 Broadway, New York. With Plates.

Measurement of the Force of Gravity and Magnetic Constants at Ogasawarajima. By A. Tanakadate. Tokio, Japan: Tokio Daigaku. Pp. 32.

Geological Sketches of the Precious Metal Deposits of the Western United States, etc. By S. F. Emmons and G. F. Becker. Washington: Government Printing-Office. Pp. 295.

Report on the Production, Technology, and Uses of Petroleum and its Products. By S. F. Peckham. Washington: Government Printing-Office. Pp. 319.

Saxe Holm's Stories. New York: Charles Scribner's Sons. Two Series. Pp. 350 and 384. 50 cents each.

Diccionario Tecnológico (Technological Dictionary), English-Spanish. By Nestor Ponce de Leon. Part 14. Socket to Tappet. Pp. 64. 50 cents.

Introduction à une Esthétique Scientifique (Introduction to a Scientific Æsthetics). By M. Charles Henry, Paris. Pp. 31.

Meteoreisen (Meteoric Iron.) Pp. 6. Die Namen der Nutzmetalle (the names of the useful metals). Pp. 6. By Professor E. Reyer, of the University of Vienna. Vienna: Published by the author.

Sur la Variabilité des Anneaux de Saturne (On the Variability of Saturn's Rings). Pp. 24, with Plate. Changements observés sur les Anneaux de Saturne (Changes observed on Saturn's Rings). Pp. 4. The Veiled Solar Spots. Pp. 4. By E. L. Trouvelot, Observatory of Meudon, France.

A Text-Book of Medical Chemistry. By Elias H. Bartley, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 376. $2.50.

Rational Communism. The Present and the Future Republic of North America. By a Capitalist. New York: The Social Science Publishing Company. Pp. 498. $1.50.

Fownes's Manual of Chemistry. From the twelfth English edition, embodying Watts's "Physical and Inorganic Chemistry." Philadelphia: Lea Brothers & Co. Pp. 1056.

A Treatise on Epidemic Cholera and Allied Diseases. By A. B. Palmer, M. D. Ann Arbor, Mich.: "Register" Publishing House. Pp. 224. $1.

A Text-Book of Nursing. Compiled by Clara S. Weeks. New York: D. Appleton & Co. Pp. 396.

Analysis of Atmospheric Humidities in the United States. By Charles Denison, M. D. Chicago: Rand, McNally & Co. Pp. 30, with Plates. $1.

Practical and Analytic Chemistry. By Henry Trimble. Philadelphia: P. Blakiston, Son & Co. Pp. 94. $1.50.

Two Years in the Jungle. By William T. Hornaday. New York: Charles Scribner's Sons. Pp. 512, with Maps. $4.

A Wheel of Fire. By Arlo Bates. New York: Charles Scribner's Sons. Pp. 383. $1.

Color Studies. By Thomas A. Janvier. New York: Charles Scribner's Sons. Pp. 227. $1.

Modern Moulding and Pattern-Making. By Joseph P. Mullin, M. E. New York: D. Van Nostrand. Pp. 257.

The Heart, and how to take Care of it. By Edwin M. Hale, M. D. Chicago. New York: A. L. Chatterton Publishing Company. Pp. 94.

Water Meters. By Ross E. Browne. New York: D. Van Nostrand. Pp. 89. 50 cents.

The Preservation of Timber by the Use of Antiseptics. By Samuel Bagster Boulton. New York: D. Van Nostrand. Pp. 223. 50 cents.

POPULAR MISCELLANY.

The New Star.—Astronomers have been surprised by the fact, which was first announced by Dr. Hartwig on the 29th of August, that a star of about the eighth magnitude had suddenly appeared in the middle of the great nebula of Andromeda. This nebula, the most conspicuous of all the phenomena of the kind, has long been regarded as a stellar nebula, since Mr. Huggins showed that its spectrum possessed the characteristics of stellar spectra, but it has never been resolved. The appearance of the new star within it, if it belong to it, which is not yet ascertained, may mark some important movement going on within it. The star was seen, within a few days of

Dr. Hartwig's observation, by several other observers, and has now become an object of interest and attention to every one who possesses a telescope. The first observation of it appears to have been by Mr. Isaac W. Ward, of Dunecht, on August 19th. It was not visible at Brussels at the beginning of August; and the Rev. S. H. Saxby, carefully observing the nebula on the 6th, 9th, and 10th of the month at Davos Platz, saw no sign of a stellar nucleus. The telescope at Dunecht on the 5th of September showed it as a star of the 7½ magnitude, with a continuous spectrum. At the Greenwich Observatory, on the 4th of September, its spectrum was shown to be of precisely the same character as that of the nebula, or perfectly continuous, with no lines, either bright or dark, visible, and the red end wanting. It therefore presents no evidence of an outburst of heated gas, such as was the case with the "temporary" stars T. Corona in 1866 and "Nova" Cygni in 1876. The appearance of new or temporary stars, though an event that must always excite remark, is not really unusual. One appeared in May, 1859, in the nebula or cluster 80 Mersier, and shone with a magnitude diminishing from the 7th till the 10th of June, when it vanished, and has never been seen since. A similar star was discovered in a nebula in the Unicorn in 1861, and is now ranked as a variable star, R. Monocerotis. The star Eta Argus, in the "key-hole nebula" in Argo, is also a variable star, whose appearance at its brighter stages might suggest to superficial observation the idea of a new or temporary star. It remains to be ascertained whether the present star really belongs to the nebula or is an outsider passing over the line of vision between us and it. Spectroscopic and photometric observations, so far as they have gone, indicate a constitution identical with that of the nebula, but they are not complete. If it does belong to the nebula, a fact mentioned by Mr. R. A. Proctor becomes very important. Mr. Spencer has pointed out that no nebula which could be resolved into stars could possibly lie outside the limits of the galaxy or of the great system of which our solar system is a member; for the outer edges of that system are so far irresolvable. It was generally agreed that, if any nebula lay outside of the system, it was this one in Andromeda. Now, if a star is distinguished in this body, it is clear also that it too must lie within our system.

Shall we raise Silk at a Loss?—In the discussion of a paper by Dr. Riley, in the American Association, advocating tariff "encouragement" of silk-culture in the United States, Mr. Edward Atkinson remarked that the project is not desirable. There is no lack of employment for labor in the United States, as the high rate of wages shows; and the fact that the making of reeled silk has been unprofitable shows that capital can be better employed. Silk-culture is a handicraft simply, and has been carried on by the poorest and most inefficient peoples, who, as they rise in the scale, abandon it, as is now coming to be the case in Southern France. The argument that we shall save the $20,000,000 which we now pay for imported silk is fallacious. When we exchange articles produced by labor costing one dollar per day, for the silk of China or Japan raised by labor costing five or ten cents a day we gain and not lose. We can not afford to do for ourselves what pauper laborers will do for us cheaper.

Chemistry at the American Association.—The Chemical Section of the Association was opened with an address by Professor W. R. Nichols, of the Massachusetts Institute of Technology, on "Chemistry in the Service of Public Health." The author showed that chemistry has an educational office to fill in the service of sanitary science, in teaching the public what its capabilities and limitations are, and correcting the erroneous ideas that are entertained as to the nature of certain processes in preparing food-substances, and the effect in them of the application of particular reagents. Respecting two subjects now much talked of in sanitary circles, Professor Nichols said: "Microbes may well be left to the biologists, and possibly sewer-gas as well, since chemists have failed to discover any substances in the gas which could produce the well-known ill effects. . . . It is asserted by some that the day of chemical examinations is passing away, and that the wholesomeness of water will be determined by the biologist, not by the chemist. Without detracting from the present value of biological methods, we can not believe that they can replace chemical examination for a long time yet; it must first become certain that all the evil effects of impure water are due to the organisms now so eagerly studied. When the biological examination of water has been placed on a firm basis, it will then be necessary to carry out the work begun by Professor Mallet, of discovering the chemical characteristics which belong to waters which a biological examination condemns, and of making the characteristics the basis of future chemical analysis. In the matter of the pollution of streams by sewage, there is much chemical work to be done." Chemistry may be made of service to public health by investigating the actual state of existing evils; in suggesting practical remedies for them; and in the examination of foods and drinks. The education of those who propose to follow these lines of work requires a thorough knowledge of general and analytical chemistry, and of physics. "There is room in the community for a class of persons knowing a little engineering, a little chemistry, a little biology, and a little of other things, an occupation legitimate and honorable, but one which does not justify our calling a person so posted a sanitary engineer or chemist."

Professor Prescott gave the results of experiments in fixing the limits of recovery of certain poisons when mixed with organic matter.

Professor F. P. Dunnington described a method of fixing crayon-drawings, by saturating them with a preparation composed of one part of Damar varnish and twenty-five parts of turpentine. The drawings are made on unsized manila paper. When dried after treatment, they are ready for use.

Professor Mabery, and the Messrs. Cowles, of Cleveland, Ohio, presented a paper on a new electric furnace and the reduction of aluminum and other metals rare in the metallic state, and the formation of a number of new useful alloys by its aid. Experiments were made in the inquiry for the best means of obtaining a continuous high temperature on an extensive scale. It was found that by introducing coarsely pulverized carbon, mixed with the oxide to be reduced, and applying the electric current, reduction was effected and the temperature was raised to such an extent that the whole interior of the retort fused completely. In other experiments lumps of lime, sand, and corundum were fused, with indications of a reduction of the corresponding metal; on cooling, the lime formed large, well-defined crystals, and the corundum beautiful red, green, and blue octahedral crystals. Following up these experiments, Professor Mabery found that the intense heat thus produced could be utilized for the reduction of oxides in large quantities; and it has already been found that aluminum, silicon, boron, magnesium, manganese, sodium, and potassium, can be obtained from their oxides with ease. Good commercial results have been derived from the application of the process, in the manufacture of aluminum-bronze of various grades, and possessing superior qualities of one kind or another according to the grade; of silicon-bronze, which promises to afford the best material for electric wires; and of boron-bronze, in which boron appears to have almost the same effect when added to copper as carbon when added to iron in the manufacture of steel.

The question, "What is the best initiatory work for students entering upon laboratory practice?" was discussed. Professor H. W. Wiley insisted on the importance of training the novitiates in habits of accuracy—that they should understand at once that chemical science is no guess-work, but a science of definite proportions. Professor R. B. Warder thought it was better to begin with metals than with gases, and Professor F. P. Dunnington suggested a course of metallurgy and assaying. Mr. Thomas Antisell remarked that much depended on the object of instruction—whether it was given only as a part of a liberal education, or with the view of making chemistry a profession. Professor Prescott thought that students should, in analytical work, practice first on known bodies before beginning on unknown; and that too much reliance should not be placed on laboratory work alone, which should be associated with rigid class-work in the lecture and recitation rooms. Professor Mabery would have young people begin with common phenomena, master the principles of stoichiometry, and work, as far as possible, quantitatively.

Physics at the American Association.—In the Section of Physics, Professor S. P. Langley read a paper on the sources of invisible radiations and on the recognition of hitherto unmeasured wave-lengths. The object of the researches he described was to ascertain whether there are other wave-lengths than those found in the sun's heat, so that we may perhaps explain how it is that the surface heat of our planet is maintained in spite of the ready radiation of extreme solar heat through the atmosphere. We have in the infra-red portion of the solar spectrum the greater part of the heat which sustains organic life on this planet, and the questions arise, Does the planet radiate heat of the wave-lengths that it receives from the sun? and how is its temperature maintained, probably several hundred degrees above the temperature of space, when our observations show that the direct radiations of heat from the sun can only raise it about fifty degrees above the surrounding temperature? Experiments at Allegheny show that the dark solar heat is transmitted by our atmosphere with less difficulty than the light; and, if the radiations of the soil are of this wave-length, our planet should actually be cooler on account of its atmosphere than if it had none. Professor Langley has for two years past made measurements of the radiations from bodies of the temperature of the earth, using for his experiments prisms and lenses of rock-salt. From the results of these researches, he says that we have every reason to believe that heat radiated by the soil has a wave-length twenty times that of the lowest visible line of the solar spectrum. His experiments thus tend to show that this heat is of a totally different quality from that received from the sun. Among the other papers read in this section were those of Professor H. S. Carhart on surface transmission of electrical discharges, in revision of work by Professor Henry; of Professor E. L. Nichols, on the chemical behavior of magnetic iron; of Major H. E. Alvord, on the results of telemetric observation at Houghton Farm; and of Commander Theodore F. Jewell, on the apparent resistance of a body of air to a change of shape. In the experiments on this subject, a disk of gun-cotton was exploded on a metal plate. Each of the disks had the letters "U. S. N" and the year of manufacture stamped upon it. After explosion upon the iron, similar indentations were found upon the plate, as if the air in the indented letters had been driven into it. Professor E. L. Nichols stated that from comparisons he had made of the spectrum of the unclouded sky with that of the sunlight reflected by magnesium carbonate, he had deduced the conclusion that the spectrum of the sky is of the same character as that of white light. The blue color of the sky and of other opalescent media is, according to these and other correlative experiments, not due to an excess of the more refrangible rays in the light reflected by them, but is of a subjective character. These results disagree with those obtained by Professor Langley in his experiments. Mr. H. Helm Clayton, of Ann Arbor, presented evidence favoring the supposition that there are at times slow progressive movements of barometric change, and of temperature from west to east, and attempted to show that the weather of the United States during the last year had been marked by certain periodicity of character.

Plants growing at Strange Heights.—Many anomalies have been observed in the distribution of plants by altitude, which M. F. Krasan has endeavored to account for, in Engler's "Annuaire botanique," by supposing changes to have taken place during the recent period in the height of the mountains on which the vegetation is found. Thus, in several valleys of the Alps, oaks are growing at unusual altitudes, and live under climatic conditions that seem to exclude them elsewhere. They do not, however, appear to be reproducing themselves, and are probably destined to be crowded out by the beeches. On the Humberg, in Southern Styria, at a height of between 750 and 1,360 feet, are found growing in the midst of vines and associated with southern plants masses of purely Alpestrine species; and in the mountain-region north of Cilli, the highest altitude of which is less than 3,000 feet, are not less than fifty-one species that occur normally in the region of pines. The Humberg is more than twenty miles from the nearest Alpine summit, yet the plants appropriate to such a situation are represented, not by individuals, but by a large mass of plants that appear to be perfectly acclimated. The mystery is heightened by the fact that in a neighboring mountain district of considerable higher altitude, which borders on a really Alpine region, only a small number of Alpine plants are found. Similar anomalies have been remarked in the Pyrenees. Many Alpine plants can and doubtless do live and thrive in lower situations than their habitual ones, and their general absence from such places is probably rather due to their being crowded out, and the ground possessed by the species more peculiarly fitted to the locality than to any positive unfitness of their own. But if a mountain is suddenly raised up or depressed, the entire vegetation growing upon it is transported to a new region. It will then offer a long and sturdy resistence to the rival species that may come in to dispute with it for occupancy; and this resistance may in the end last long enough for the species to become acclimated to the new conditions, when they will reproduce themselves, and the phenomena under consideration will be manifested.

Metal-working Art in Cashmere.—Herr Carl von Ujfalvy, who has been exploring in the western Himalayas, asserts that the Cashmereans must be regarded as the noblest of the Indian races. "At least," he says, "it must be admitted that a people that prepares its food in handsome kettles of beaten and carved copper, adorned with tasteful engravings, drinks its tea and coffee from elegantly shaped pots, and uses showily decorated pitchers and cups, and beaten and enameled dishes, vases, pipes, candlesticks, lamps, tea-vessels, and plates, and engraved spittoons, must have a peculiar artistic gift. What is more remarkable is that objects of such character are in daily use, not only in the mansions of the rich, but also in the peasants' huts; and any one who takes this fact into consideration must say that we have to do with a particularly endowed race of Aryans, who, too small in numbers and too weak to contend with the barbarians, have found satisfaction in devoting themselves to art. When we reflect," adds Herr von Ujfalvy, "that all the household utensils in High Asia, Persia, and India, and the innumerable idols in the latter country are made of beaten or cast metal, we may be able to form an approximate idea of the importance and extension of this industry in all those countries." Copper is the basis of these industries, either pure, in hammered, beaten, and carved forms, or alloyed or set off with gold, silver, steel, tin, lead, or zinc. In Turkistan a yellow, in Kashgar a red, in Cashmere an ornamented red metal is worked. Yellow metal is here of very ancient origin. The metal industry is most extensively developed and most flourishing in Cashmere; and there no difference is recognized between art-work and mechanical work, and it is therefore not strange that we should so frequently meet with real masterpieces of art.

Blind Men's Dreams.—How do the blind dream? is discussed by Mr. B. G. Jones, in the (English) "National Review." In nearly all ordinary dreams we imagine we see something—persons or things, or both. This can not happen with the blind, who have no conception of things that are seen; or, if they were not born blind, of things that they had not seen before they lost their sight. The blind man may recall a person or a place, but his recollection can only be commensurate with what he has obtained by the senses of touch, hearing, or smell. A blind boy dreamed of his brother who was dead. He knew him by his voice, and he also knew he was in the fields with him, for he felt himself treading upon the grass and smelling the fresh air. His idea of a field could not possibly reach much beyond this. Another person dreamed he was in his workshop; he knew this by sitting on a box, and by the tools which were in it. A blind tramp said when he dreamed it was just the same as when he was awake—he dreamed of hearing and touching. A blind man is mentioned who dreamed of a ghost, and this is the way he told his story: "I heard a voice at the door, and I said, 'Bless me, if that ain't John!' and I took him by the sleeve; it was his shirt-sleeve I felt; and I was half-afeared of him, and surprised he was out weeks before his time.

Then (in my dream) I dreamt that he tried to frighten me, and make believe he was a ghost, by pushing me down sideways, etc. After that I waked and heard no more." We fancy ghosts as impalpable beings, clothed in white. Blind men can hardly have as distinct an imagination of their appearance.

A Workmen's Scientific Class.—How knowledge may be disseminated by means of local lectures to working-men is illustrated in a story told by Mr. Roberts, of Cambridge. Two miners, at Buckworth, England, walked four or five miles and back in the evening, after work, to attend the course at Cramlington. Finding others in their village wanting to know something of chemistry, but not able to attend the course, they took to repeating to a class of seven on the next evening the lectures they had heard, and, having supplied themselves with chemicals, repeated the experiments. Mr. Roberts attended one of the meetings of this class at the end of the term, examined the members, and found that they had acquired a sound enough knowledge of the subject to pass the regular university examination. The class were this summer to carry on in the same manner a course in physiology, in aid of which they were endeavoring to procure a microscope.

Mechanical Science at the American Association.—The vice-presidential address of Professor J. Burkitt Webb, in the Section of Mechanical Science, was on "The Second Law of Thermo-dynamics," but was too technical for abstract in these pages. Mr. L. S. Randolph gave an account of his experiments in seeking for an explanation of the peculiar manner in which the stay-bolts between the fire-box and the boiler-shell of steam-boilers had been found to break. He indicated a drawing and bending of the bolts occasioned by the shifting of the plates under changes of temperature as the cause, aided by the corrosive action of the water that might reach the bolts. Mr. Stephen S. Haight presented a paper on the use and value of accurate standards for surveyors' chains. He exhibited a specimen chain of flattened steel wire, with thermometer attached to record temperature, a spring-balance to weigh the tension, and a spirit-level. Professor Davis exhibited a tape which he had found accurate enough for general use in a large range of work in Michigan. Professor J. B. Webb read a paper on the lathe as an instrument of precision, in which he called attention to the desirability of greater accuracy in instruments of this class, and described some simple methods for making tests of the degree of error in any particular instrument. Professor Cooley explained a new smoke-burning device. A committee report was presented and a discussion had on the best methods of teaching mechanical engineering. The object of the instruction being admitted to be thorough preparation in theory and principle, Professor Thurston said that the training should be adapted to the work to be done, and that he therefore favored classification into manual training-schools, schools of mechanic arts, and schools of engineering. It was asserted by other speakers in the course of the discussion that there are no manual training-schools where a boy can learn a trade before entering the higher schools; and that the St. Louis and Chicago manual training-schools will not make workmen, and probably not five per cent of their students will ever become workmen.

Science in Common Schools.—The committee of the American Association on methods of science-teaching in the schools stated that much had been accomplished in the investigation, in which many associations, schools, and persons had interested themselves. The committee of conference with foreign associations in reference to an international convention of science associations had conducted an extensive correspondence, and the subject was to be brought before the British Association at Aberdeen. An endowment fund of twenty-five thousand dollars had been given to the scheme by Mrs. Elizabeth Thompson, of Stamford, Connecticut. The committee was continued as the "Committee on International Scientific Congress." The committee on the encouragement of researches upon the health and diseases of plants reported that at its suggestion the Commissioner of Agriculture had appointed Mr. F. L. Scribner, of Girard College, Philadelphia, to take charge of a section in his department, devoted to work of that character.

The British Association.—The British Association met at Aberdeen, Scotland, September 9th, and was opened by the president for the year, Sir Lyon Playfair, with an address which we publish in the present number of the Monthly. Among the more noteworthy papers presented were the vice-presidential addresses of Professor H. E. Armstrong, on more efficient methods of teaching chemistry; of Professor Judd, in the Geological Section, on some unsolved problems of Highland geology; of Mr. B. Baker, of the Mechanical Section, calling attention to deficiencies in bridge construction; of Mr. Galton, in the Anthropological Section, on "Types and their Inheritance"; and of Professor Sidgwick, of the Section of Economical Science and .Statistics. In the last section Professor Leone Levi read an elaborate paper on "The Alleged Depression of Trade; its Causes and Remedies."

New Problems in Chemistry.—In his address as Vice-President of the Chemical Section of the British Association, Professor H. B. Armstrong criticised the way in which the science is taught in the schools, and insisted upon the importance of giving more prominence to research by the students, and of cultivating in them the spirit of original investigation. They must not merely be taught the principles and main facts of the science, but must be shown how the knowledge of those facts and principles has been gained, and must be so drilled as to have complete command of their knowledge. Chemistry was no longer a purely descriptive science. The study of carbon compounds and Mendelejeff's generalization had produced a complete revolution. The faults in the present system of teaching were precisely those which had characterized the teaching of geography and history, and which were now becoming so generally recognized and condemned. Both in teaching and examining two important changes ought to be made. The students ought at the very beginning of their career to become familiar with the use of the balance; and the imaginary distinction between so-called inorganic and organic compounds should be altogether abandoned. Touching on the progress that had been made in chemical theory, Professor Armstrong mentioned the change which had taken place in views concerning chemical action. Hitherto it appeared to have been commonly assumed and almost universally thought by chemists that action took place directly between A and B, producing A B, or between A B and C D, producing A C and B D. In studying the chemistry of carbon compounds, they became acquainted with a large number of instances in which a more or less minute quantity of a substance was capable of inducing change or changes in the body or bodies with which it was associated without apparently itself being altered; but so little had been done to ascertain the influence of the contact-substance, or catalyst, as he would term it, that its importance was not duly appreciated. Recent discoveries, however, must have given a rude shock, from which it could never recover, to the belief in the assumed simplicity of chemical change. Then, after considering briefly some questions of the relations of chemical and electrical action, Professor Armstrong went on: Complaints are not unfrequently made that a large proportion of published work is of little value, and that chemists are devoting themselves too exclusively to the study of carbon compounds, and especially of synthetic chemistry; that investigation is running too much in a few grooves, and that we are gross worshipers of formulæ. But the attention paid to the study of carbon compounds may be more than justified, both by reference to the results obtained and to the nature of the work before us. "The inorganic kingdom refuses any longer to yield up her secrets—new elements—except after severe compulsion. The organic kingdom, both animal and vegetable, stands ever ready before us. Little wonder, then, if problems directly bearing upon life prove the more attractive to the living. The physiologist complains that probably ninety-five per cent of the solid matters of living structures are pure unknowns to us, and that the fundamental chemical changes which occur during life are entirely enshrouded in mystery. It is in order that this may no longer be the case that the study of carbon compounds is being so vigorously prosecuted. . . . As to the value of the work, I believe that every fact honestly recorded is of value." No unprejudiced reader can but be struck with the improvement in quality which is manifest in the majority of the investigations now published. The great outcome of the labors of carbon chemists has been the establishment of the doctrine of the structure. That doctrine has received the most powerful support from the investigation of physical properties, and it may almost, without exaggeration, be said to have been rendered visible in Abney and Festing's infra-red spectrum photographs.

Limits of Stress on Iron Bridges.—Addressing the Mechanical Science Section of the British Association, Mr. B. Baker spoke of the want of understanding among engineers regarding the admissible intensity of stress on iron and steel bridges, concerning which "at the present time absolute chaos prevails. The variance in the strength of existing bridges is such as to be apparent to the educated eye without any calculation. . . . It is an open secret that nearly all the large railway companies are strengthening their bridges, and necessarily so, for I could cite cases where the working stress on the iron has exceeded by two hundred and fifty per cent that considered admissible by leading American and German builders in similar cases. . . . In the present day engineers of all countries are in accord as to the principles of estimating the magnitude of the stresses on the different members of a structure, but not so in proportioning the members to resist those stresses. The practical result is, that a bridge which would be passed by the English Board of Trade would require to be strengthened five per cent in some parts and fifty per cent in others before it would be accepted by the German Government, or by any of the leading railway companies in America." This undesirable state of affairs arises from the fact that "many engineers still persistently ignore the fact that a bar of iron may be broken in two ways—namely, by the single application of a heavy stress, or by the repeated application of a comparatively light stress. An athlete's muscles have often been likened to a bar of iron, but, if 'fatigue' be in question, the simile is very wide of the truth. Intermittent action—the alternative pull and thrust of the rower, or of the laborer turning a winch—is what the muscle likes and the bar of iron abhors. From tests made several years ago by royal commissioners, the deduction was made that "iron bars scarcely bear the reiterated application of one third the breaking weight without injury, hence the prudence of always making beams capable of bearing six times the greatest weight that could be laid upon them." Hundreds of existing railway-bridges which carry twenty trains a day with perfect safety would break down quickly under twenty trains an hour. Although many more experiments are required before universally acceptable rules can be laid down, "I have thoroughly convinced myself that, when stresses of varying intensity occur, tension and compression members should be treated on an entirely different basis."

Some Aspects of Heredity.—Mr. Francis Galton spoke, in the Anthropological Section of the British Association, from his researches in family histories and records, on types and their inheritance. He discussed the conditions of the stability and instability of types, and urged the existence of a simple and far-reaching law governing the hereditary transmission. From experiments he had made several years before on the produce of seeds of different size but the same species, it appeared that the offspring did not tend to resemble their parent-seed in size, but to be always more mediocre than they—to be smaller than the parents if the parents were large, to be larger than the parents if the parents were very small. The special subject of this paper was hereditary stature, where a similar law seemed to prevail. His data consisted of the heights of nine hundred and thirty adult children and their parentages, two hundred and five in number. The child inherits partly from his parents, partly from his ancestry. Speaking generally, the further his genealogy goes back, the more numerous and varied will his ancestry become, until they cease to differ from any equally numerous sample taken at hap-hazard from the race at large. Their mean stature will then be the same as that of the race, or mediocre. The average regression of the offspring to a constant fraction of their mid-parental deviations, which was first observed on the diameters of seeds, and then confirmed by observations on human stature, is now shown to be a perfectly reasonable law, which might have been deductively foreseen. This law tells heavily against the full hereditary transmission of any rare and valuable gift, as only a few of many children would resemble their mid-parentage. The more exceptional the gift, the more exceptional will be the good fortune of the parent who has a son who equals, and still more if he has a son who overpasses him. This law is even-handed; it levies the same heavy possession-tax on the transmission of badness as well as of goodness. If it discourages the extravagant expectations of gifted parents that their children will inherit all their powers, it no less discountenances extravagant fears that they will inherit all their weaknesses and diseases. The number of individuals in a population who differ little from mediocrity is so preponderant that it is more frequently the case that an exceptional man is the somewhat exceptional son of rather mediocre parents than the average son of very exceptional parents.

Vision of the Honey-Bee.—According to the Rev. J. L. Zabriskie's observations, the honey-bee sees as through the woods. The ocelli are situated on the top of the head, arranged as in an equilateral triangle, so that one is directed to the front, one to the right, and one to the left. "Long, branching hairs on the crown of the head stand thick, like a miniature forest, so that an ocellus is scarcely discernible except from a particular point of view"; and then the observer remarks an opening through the hairs—a cleared pathway, as it were, in such a forest—and notes that the ocellus, looking like a glittering globe half immersed in the substance of the head, lies at the inner end of the path. The opening connected with the front ocellus expands forward from it like a funnel with an angle of about fifteen degrees. The side ocelli have paths more narrow, but opening more vertically; so that the two together command a field which, though hedged in anteriorly and posteriorly, embraces, in a plane transverse, of course, to the axis of the insect's body, an arc of nearly one hundred and eighty degrees.

NOTES.

Dr. C. Keller, of Zürich, claims that spiders perform an important part in the preservation of forests by defending the trees against the depredations of aphides and insects. He has examined a great many spiders, both in their viscera and by feeding them in captivity, and has found them to be voracious destroyers of these pests; and he believes that the spiders in a particular forest do more effective work of this kind than all the insect-eating birds that inhabit it. He has verified his views by observations on coniferous trees, a few broad-leaved trees, and apple-trees. An important feature of the spiders' operations is that they prefer dark spots, and therefore work most in the places which vermin most infest, but which are likely to be passed by other destroying agents.

The New England Meteorological Society has been making a special study of thunderstorms. A series of circulars was prepared and sent out, explaining the details of the work. Several classes of observations were contemplated. On the 9th of June more than two hundred and fifty observers had offered their services.

A Women's Anthropological Society was organized in Washington, June 8th, with Mrs. Colonel James Stevenson as President, Mrs. Romeyn Hitchcock Recording Secretary, and Miss S. A. Scull Corresponding Secretary. Miss Cleveland was requested to name the society, and did so.

The "Bulletin" of the French Geographical Society gives some curious details about the system of numeration of the Indians of Guiana. It is based upon the five fingers of the hand. The Indians have names for only four numbers, corresponding with the four fingers; then, when they come to five, they say, not five fingers, but "a hand." Six is "a hand and first finger"; seven, "a hand and second finger"; ten, "two hands"; fifteen, "three hands"; twenty, not "four hands," but a man. From this they proceed by the system of twenties. Forty is "two men"; forty-six, "two men, a hand, and second finger."

The humming of telegraph and telephone wires, so often heard, is generally considered to be caused by the wind. Mr. R. W. McBride, of Waterloo, Indiana, who specially studied the matter for several years on his private wire, which had a strong gift of humming, is satisfied that the wind is not the agent, for he found the sound more likely to be heard on a dry, clear, cool, and calm evening than at any other time. He is also convinced that the sound is not produced by electricity; for he could detect no signs of that agent when the humming was going on, while at times when the wire was evidently charged there was no sound. The humming was accompanied by a rapid vibration of the wire. Mr. McBride considers the question a subject of investigation which may lead to important discoveries.

Dr. Carl H. von Klein, of Dayton, Ohio, claims to have discovered a process for converting garbage and sewage matter into an odorless and clean fuel. He treats refuse, to disinfect and deodorize it, with salt, slacked lime, and a little nitric acid to start the fumes; then, after eight days, with sal-soda. The composition will solidify in a few days, when it is pressed into bricks and dried till it is in fit condition to be used. It produces a better flame, the inventor says, and retains more heat, than Alleghany coal, and costs but little more than half as much as the cheapest other fuel in the market.

Lieutenant-Colonel Playfair observed, in the Geographical Section of the British Association, that his experience in Tunis had proved in the most forcible manner the importance of preserving forests. In Roman times the province of Africa and the territory of Carthage were the granary of Europe. In what was now practically a desert, the remains of magnificent Roman farms were everywhere found. The small hill-sides were now nothing but sands. This was entirely due to the destruction of the forests with which they used to be covered; for the vegetable soil had been washed away into the valleys, and there it was now to be found buried beneath some feet of sand and water-worn pebbles.

A scheme is on foot to establish a botanic garden in Montreal. A tract of seventy-five acres of land near the base of the mountain is promised by the city, and subscriptions are solicited for means to fit it up and supply collections.

The French Association at Grenoble was well attended, and excited much interest among the people of the city. The subject of the inaugural address of President Verneuil was surgery in 1885, and the address is said to have been much more interesting than the subject promised.

OBITUARY NOTES.

Professor J. J. A. Worsaae, the eminent Danish archæologist, died suddenly August 15th. He was born in 1821. He was made inspector over antiquarian monuments in Denmark when twenty-eight years old. Having labored for many years with Professor Thomsen, who first established the division of the stone, iron, and bronze ages, in arranging the Museum of Northern Antiquities, he continued the work after his death in 1865, and brought the museum to its present state of perfection and richness in treasure. He was Minister of Worship and Public Instruction in 1874–'75. He was the author of several works on the antiquities and early history of Denmark, and on the conquests achieved by the Northmen.

Mr. William John Thoms, formerly editor of "Notes and Queries," died August 15th, in his eighty-second year. His work was partly literary, but mainly in the line of antiquarian research. As editor of "Notes and Queries" he had often to deal with scientific matters; and he was a vigorous contestant of the claims of all persons who assumed to be centenarians, insisting that no one had ever lived to be more than a hundred years old.

Commandant Léon Brault, of the French marine, who died at Argenteuil on the 27th of August, was a meteorologist, and author of a series of meteorological charts, for which he received gold medals at the Exposition of 1878 and from the Geographical Congress of Rome. He contributed valuable papers on his favorite science to the first ten years' volumes of the journal "La Nature" and to the "Revue Scientifique," and was author of a number of monographs on subjects of meteorology.

Philip Leopold Martin, taxidermist and *muscologue*, died in Stuttgart, March 7th, aged seventy years. He was the author of an illustrated "Natural History of Animals," which was published in Leipsic in 1882–'84; and of a work on the praxis of natural history, relating to taxidermy, dermoplastics, and museology, in three volumes.

Dr. Johannes August Christian Röper, Professor of Botany at Rostock, died March 17th, aged eighty-four years. He was author of papers and works on the spurges of Germany and Pannonia, the organs of plants, the flowers and affinities of the *Balsimaneæ*, the grasses, and the flora of Mecklenburg, and the Darwinian theory, and translated De Candolle's "Plant-Physiology."

Dr. Karl Jacob Zoppritz, Professor of Geography in the University of Königsberg, died a few months ago. He was born in 1838. His principal work in geography was the reduction of the barometric altitude-measurements of travelers.

ALPHEUS HYATT.

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THE SCIENTIFIC STUDY OF RELIGIONS.

By the Count GOBLET D'ALVIELLA,
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THE general history of religions is taught, if I am not mistaken, only in Leyden, Paris, Tübingen, and Geneva. In giving a place to this new branch, the University of Brussels has again shown its fidelity to the liberal spirit that actuated its founders. Imperfectly qualified as I am to give direction to studies on this subject, I am encouraged to undertake it by the thought that to teach the history of religions, it is not necessary to be acquainted with all the languages of all the peoples who have professed them. I am far from depreciating such knowledge, and readily recognize that the founders of the science of religions have nearly all been trained in special studies of this very kind. But all the branches of the ancient literatures, through the discoveries of those who have so laboriously delved in them, now offer general results sufficiently certain and well developed to enable us, without doing over the work of the specialists, to attempt the synthesis of their conclusions, and relate the history of religions as we do the history of arts, sciences, languages, or peoples.

Henceforth the science of religions will be chiefly a question of method and assimilation. As Professor Tiele stated in 1877, for the Assyrio-Babylonian religion: "The historian, the ethnologist, and the scholar, who devote themselves to the science of comparative religions, have each their several tasks. The domain they occupy can no more be disputed as against them than they can encroach upon that of the epigraphist and the philologist."

It might be asked why, if it is so easy to get positive information on the nature of the different religions, it is not more widely diffused.

It is principally because, aside from a few fugitive notions, often quite obsolete, on the mythology of Greek and Latin antiquity, the history of religions is wholly unprovided for in our courses of instruction; and, secondly, because there prevails a mass of prejudices tending to restrict the application of scientific methods to this study.

Among these prejudices there are some which are always found, although in a less degree, in all the subdivisions of historical science, while others are peculiar to this particular branch. Some of them tend to hinder even the existence of hierography, while others simply falsify its applications or vitiate its conclusions. My object is to point out the most formidable of these prepossessions by exhibiting, through a few examples, the mistakes into which they may cause even the best-intentioned persons to fall.

We will begin with examining some prejudices that are connected with the very object of our study—the religious and the anti-religious prejudice. It should be understood that when I use the word prejudice in this connection, I employ it in its etymological sense of a judgment fixed in advance, and not in the ordinary sense of something offensive. Our purpose is to study religions, not to insult them.

Max Müller has written that there have existed two systems broad enough to tolerate a history of religions—primitive Buddhism and Christianity. He doubtless meant Christianity as he professes it, and as he saw it professed around him—the Christianity of Stanley and Colenso, of Maurice and Martineau, of Kuenen and Tiele, of Reville and Lenormant. He does not hesitate to recognize with what facility one may be led away from the historical method by belief in the possession of a supernatural revelation, when this revelation is formulated by the agency of a man of reputed infallibility, of a church assembled in council, or of a book finished and closed forever: when it pretends to trace around its affirmations a circle impenetrable to free examination, it is wanting in the most essential conditions for passing serious criticism. When the believer's right to interpret the sacred books is acknowledged, a place is left open for exegesis, but that exegesis still remains the slave of particular texts or dogmas that limit and consequently trammel it.

Let us take a single story from the Bible—that of Jonah, and examine the different acceptations it has received. We could hardly find a richer stock of interpretations vitiated by what I call the religious prejudice. According to the rationalist mode of interpretation that flourished in Germany at the beginning of this century, Jonah was an envoy from Israel to Nineveh, who was picked up after having been shipwrecked, three days from the shore, by a ship carrying the image of a whale as its figure-head. Another interpretation is that of Grimm, that the whole history passed off in a dream. This is to save the letter, but at the expense of the spirit. The important matter in the critical study of a text is to find what its authors intended to put in it, and not what it ought to contain in order to conform to our ideas of truth or of justice. "There have been and still are," said Dean Stanley, relative to these points, in his funeral address on Sir Charles Lyell at Westminster Abbey, "two methods of interpretation which have wholly and justly failed: the one that attempts to distort the real sense of the words of the Bible, to make them speak the language of science; and the one which tries to falsify science, in order to satisfy the supposed exigencies of the Bible." *

We pass next to the symbolic interpretation. There is nothing to prevent our seeing in Jonah the symbol of the soul, and in the whale that of death or the tomb, so that we might reduce it all to an allegorical representation of man's immortality, such as we see among the monuments of the Catacombs. Or, we might imagine, with Professor Herman von der Hardt, that the vessel in the storm is a figure of the Jewish state, its captain of the high-priest Zadok, and Jonah of King Manasseh, taken prisoner by the Babylonians.† I am far from despising the value of this method of reconciling faith with reason, and I have not the courage to blame those who seek thus to save the integrity of their beliefs. But if symbolism permits the accommodation of religious tradition with the progress that has been made in most of the sciences, one branch of knowledge must be excepted from the rule, and that is history, whose mission is to ascertain, not if the old bottles will hold new wine, but what was put into them in the first place.

There is, however, one means of reconciling independence in criticism with belief in the divinely inspired character of a story. It consists in limiting the inspiration to the philosophical and moral truths included in the text, and letting the rest go. Thus, what in the book of Jonah may be of divine origin are the exalted lessons to be drawn from it respecting the prophetic mission of Israel, on the efficacy of repentance for the forgiveness of sins, and on the equality of Jews and Gentiles before God. And there is nothing to prevent our seeing in the incident of the whale and the other fabulous details of a narrative which M. Edouard Reuss calls a moral story, a simple invention to give more force and color to the religious and moral lessons, or perhaps a reminiscence of the mythical adventure attributed by the cuneiform texts to Bel Merodach,‡ and which is found besides in the solar mythologies of the Greeks, the Polynesians, the Algonquins, and the Caffres, and in the oldest version of "Little Red Riding Hood." Instead of losing by this, the book of Jonah becomes, as M. Kuenen

* The defenders of the Bible have not been the only ones to venture in this way. Thus, M. Jules Soury, in his desire to make the cylinders square with the doctrine of evolution, once asserted the entire conformity of the Chaldean creation myths with Darwin's theories of the origin and transformation of species. ("Le Temps," 13th and 23d November, 1879.)

† See the "Book of the Twelve Minor Prophets," by E. Henderson, London, 1845, p. 200.

‡ Professor Sayce, "Chaldean Genesis," vol. iii.

remarks, the book of the Old Testament farthest removed from Jewish particularism, and most nearly approaching to Christian Catholicity; and this should be ample compensation for the sacrifice of its miraculous and supernatural part. M. Francis Lenormant has applied the same method in his studies on the "Origins of History according to the Bible and the Traditions of the Oriental Peoples." "I do not recognize," he writes, "a Christian science and a freethinking science; I admit only one science, the one that has no need of any other epithet, which lays aside theological questions as foreign to its domain, and of which all seekers in good faith are the servitors, whatever may be their religious convictions. That is the science to which I have consecrated my life; and I believe it would be a violation of a holy duty of conscience if, influenced by a preoccupation of another kind, however worthy of respect, I should hesitate to speak sincerely and without ambiguity the truth as I discern it."

It is nevertheless true that hitherto orthodoxies have hardly shown themselves disposed to understand the rights of science in this way.

If religious prejudice opposes itself to the scientific study of one's own religion, can it also interpose an obstacle to the knowledge of strange religions? At first thought we might be tempted to answer in the negative. How can any opinions, even those which we hold as absolute truth, prevent us from observing, classifying, and describing the beliefs, or, if you prefer, the errors of another?

It is a fact that, if we arrange all religious opinions in two categories—that of our own, which we believe came down ready-made from heaven, and that of the religions of others, which we declare indiscriminately to be the results of perversions—we become incapable of grasping the real nature of the religious sentiment, and consequently of its different manifestations. With the Iranians, who personify their supreme being in the great Ahura, the *devas* represent the agents of the bad principles. To the Brahmans, who adored the devas, the *asuras* were the adversaries of gods and men. To the historian of religions, asuras and devas are analogous conceptions, which *a priori* he connects with the normal development of the human mind, and *a posteriori* shows to have been derived from the same religious center, anterior to the separation of the Persians and the Indians, and to the organization of dualism in the Aryan theologies.

How shall we preserve the even mind and the freedom of appreciation essential to all impartial analysis of foreign ideas and customs, if we imagine, like some of the fathers, that they are the work of the evil-one? The Christians of the first centuries had no doubt of the real existence of the pagan divinities, but they regarded them as evil spirits who had turned the worship of men from the only God by a caricature of the true religion. Such is likewise the recent explanation given by Father Huc of the curious resemblances which he discovered between the rites of Buddhist worship and some of the practices of Roman Catholicism.

It would be unjust to award to Christendom the monopoly of intolerance. The Emir Hakem had collected at Cordova a great number of books which had been found in the East among the ruins of paganism. The usurper Al-Mansour had them torn up and burned. Those which escaped this reaction of Mussulman fanaticism perished, three centuries later, with eighty thousand manuscripts that Roman Catholic fanaticism caused to be thrown into the flames of Granada, after the expulsion of the Moors.* Even the Protestants are not free from reproach in this matter. Sir George Mackenzie relates, in his "Travels in Iceland," that the Lutheran clergy used all its power to prevent the first publication of the "Eddas," the ancient epics of Scandinavian mythology.

Greeks and Trojans were not more bitter in their disputes over the body of Patroclus than Protestants and Catholics in wresting honestly the texts of the fathers and the monuments of the Catacombs to deduce from them the justification of their respective views on the questions in controversy between them. What should we expect, then, when the question is one of giving to a rival cult the place which legitimately belongs to it in the development of man? Bishop Huet would find but few imitators in this age of his efforts to discover Moses in the persons of Zoroaster, Orpheus, Apollo, Vulcan, Faunus, Thoth, Adonis, and Tammuz.† But even the best-informed and most sincere apologists allow themselves to exaggerate the antiquity of the Hebrew traditions while looking for the source or the affiliations of the biblical stories.

Thus, we had long known, from fragments of ancient authors, that the Babylonians had a cycle of legends presenting some analogies with the traditions of Genesis. They were generally believed to be an infiltration or a vague echo of the Mosaic account. But in 1872 Mr. George Smith deciphered from a Ninevite tablet an account of the deluge, which was singularly like the Hebrew version in the details of the composition, the course of the narration, and the style. The priority of this document to the first book of the Bible seems established in evidence. Lenormant declares that it must have been composed several centuries before Moses. The Babylonian version illustrates the original signification of the tradition, by showing it to be a myth of a great storm or of the rainy season; while, in the Mosaic version, the naturalistic character almost disappears under the more elevated interpretation, conceived from the moral and monotheistic point of view. We, therefore, seem authorized to conclude that, if the story in Genesis is not derived directly from the Chaldean tradition, the latter

* Ernest Renan, "Averroës et l'Averroism," pp. 4, 60.

† But we have recently seen—probably by way of reprisal—M. Jacolliot finding in Moses, as well as in Menes and Minos, the Manu of India.

nevertheless represents a version much nearer to the common source. Yet the contrary opinion prevails among the majority of orthodox students, because they take as their point of departure the necessary infallibility and priority of Genesis.

Sometimes the prejudice is frankly avowed. In January, 1880, the Abbé de Broglie began at the Catholic Institute of Paris a course on the history of non-Christian religions, and the "Polybiblion" of the next month gave the following summary of his opening lecture: "He proposes to show from the history of the most widely spread false cults that they are not to be compared with Christianity, and, coming down from generalities to a more special study, he will make a brilliant demonstration of the superiority of our religion." This is not history, but apologetics.*

We very frequently meet with an inverse kind of apologetics among the adversaries of religious ideas. In fact, the anti-religious prejudice, which rests, like the religious prejudice, on an exclusive view of things, is a direct result of dogmatic intolerance. If one is in the habit of regarding the ideas of others as a heap of superstitions and impostures, it is easy to conceive that, when he loses faith in the supernatural origin of beliefs, he will confound all the religions of the earth and the religious sentiment itself in a contempt that will henceforth recognize no exception.

Some think that to occupy themselves with religions is to waste time; as if religious questions did not figure among the vital questions of our epoch. "When I published the translation of the 'Life of Jesus,' by Strauss," writes Littré,† "the objection was made, from the point of view of the freethinker and revolutionist, that I was undertaking a wholly useless work, and one that was out of date, and that the eighteenth century had performed, better than all the Strausses in the world, all the work of demolition that was needed. Yes, the negative work, but not the positive work. And this is no subtile distinction that stops short of going to the bottom of things. Let us consider the aberrations that haunted the mind of the eighteenth century on the subject of religions. It was impossible for it to comprehend anything of their origin, of the part they played, or of their life. They were, according to some, inventions of crafty men who worked upon popular credulity and thereby gained power and wealth. According to others, nothing could be seen in them but periods of ignorance and superstition which it was impossible sufficiently to de-

* The abbé seems to have recognized this himself, for at the beginning of his third year (1881–'82) on the "History of the Religions of India," he changed the title of his lectures to "Course of Christian Apologetics." What, now, becomes of the compliment addressed by the "Polybiblion" to the Catholic Institute of Paris for having inaugurated a course on "Comparative Religion" before the state, with the resources of the budget at its disposal, organized one at the Collége de France?

† See the review "La Philosophie Positive," vol. xxii, p. 368.

spise or lament. According to others, again, some favor might be granted to Jupiter and Olympus, for whom magnificent temples and beautiful statues had been erected; but the flood of historical indignation must be turned upon the shame of shames, of Christianity and the middle ages. Such aberrations, with all their variations, form a vast network of prejudices which is not yet broken up and which still holds bound in its toils the whole radical party of France."

Some minds, struck by the ills which religions have engendered, are willing to admit the utility and even the necessity of hierography; but they do not pretend to look for anything in the science but arguments, or weapons, with which to contest the various forms of belief around them.

Is there any need of explaining that such can not be the purpose of this course? In saying that I will try to treat religions by the processes of science, I am by implication engaged to make neither an anti-religious polemic nor a religious propaganda. Parties and sects are at liberty to draw all the conclusions they please from science; but science should never stoop to be their instrument or sign.

When, in 1879, the French Senate discussed the scheme for introducing the history of religions into the Collége de France, Edouard de Laboulaye became the spokesman of a prejudice that disputes even the possibility of using historical methods in the study of any religion, saying: "When you believe it is true, everything will seem natural to you. When you believe it is false, everything will seem absurd. How are you going to find a way of teaching impartially?"

Henry Martin replied: "I do not say that the comparative history of religions will be to the profit of intolerant religious ideas that proscribe one another as they proscribe irreligious ideas; but it will surely be to the profit of the idea of that universal religion which lies at the bottom of all religions, and is their essence."

I will go further, and say that the historian of religions need not be at the trouble of asking whether the object of the religious sentiment is real or not, or, in other words, whether the belief in the existence of the Deity is well-founded or illusory.

I would also add that, to write the history of religions, it would be necessary to put one's self at the positivist point of view, provided this phrase is not taken to signify a formal adhesion to the philosophical system of Auguste Comte, who also has come to hierography with a preconceived theory. Here, again, I enter upon a new order of prejudice, the *philosophical prejudice*, or that which involves finding in the facts the confirmation of a doctrine determined upon in advance. Orthodox positivism omits from its scientific classification, experimental psychology, the study of which is indispensable, as Herbert Spencer declares, for obtaining the key to the religious sentiment and its evolutions. When the positivists affirm that man must pass, in his individual and social development, through the theological, metaphysical, and positive stages, they mistake for successive stages three different aspects of the human mind. And, when they declare that all religions must have traversed *successively* the three phases of fetichism, polytheism, and monotheism, they again sacrifice the facts to the spirit of system. By fetichism, Comte understands the worship of material objects, trees, stones, shells, rivers, mountains, celestial bodies, etc., which the imagination of the primitive man arbitrarily invested with supernatural powers, without, however, seeing in them the work or residence of a spirit. But the numerous observations made in our days on non-civilized peoples tend to establish, as Max Müller, Herbert Spencer, Albert Reville, and many others have superabundantly demonstrated, that fetichism as thus understood is nowhere a primitive religion; that it always accompanies and presupposes belief in spirits lodged in things or wandering in space; that it is unknown among people who are placed at the bottom of the religious scale, and reaches its *maximum* among nations that are relatively advanced.

If by fetichism we understand, with M. Girard de la Rialle, "the tendency to regard all phenomena, all beings, and all the bodies of nature as endowed with wills and feelings like those of man, with only a few differences in intensity and activity" *—which constitutes the religious state defined as Naturism by M. Albert Reville—I am ready to admit that something of the kind may have been the first form of religious practice. But the definition goes no further than that of the orthodox positivists, for it implies a previous distinction of body and mind, and worship is in reality exclusively addressed to the latter. Mr. Frederic Harrison maintains that the official religion of China had preserved the type of primitive fetichism, because in it the sky, the earth, and the heavenly bodies were adored, considered objectively, and not as the residences of immaterial beings. Now, all those who have closely studied the ancient religion of the Chinese Empire tell us that veneration is addressed, not to the material appearances of the phenomena of nature, but to the invisible spirits of which the sky, the earth, and the constellations appear respectively as the inseparable envelope, the sensible manifestation, the vestment, or the body. As to adoration of material objects frankly regarded as such, fetichism is a secondary derivative, and not the first form of the religious sentiment.

Another philosophical prejudice, of a contrary bearing, is the one that represents the historical religions as the feeble echo of a primitive monotheism, qualified by natural religion. It seemed to receive a striking confirmation in the first half of this century, when the most ancient monuments of Eastern thought put off their veils before our dazzled eyes. All that we had known till then of the religions professed among the Hindoos, Persians, and Egyptians, with their monstrous idols, their barbarous practices, and their incoherent and coarse

* "Mythologie Comparée," Paris, 1878, p. 2.

myths, seemed either an ignorant distortion, or a willful disguise of the pure and profound doctrines taught in the earliest ages of the world.

From Germany, where the symbolical school of Creuzer had pretended to find in the ancient fables allegories veiling the treasures of primitive religion, this illusion passed to France and to England, where it still has many adepts.

A more complete and more minute study of the documents in which it was believed the echoes of primitive humanity could be found, has discovered that they contain much chaff mixed with the good grain; that they depict, not a monotheism in its decline, but a monotheism in course of formation; and that they are the product of a long sacerdotal elaboration, not the primary expression of the religious feeling in its contact with Nature.*

Nowhere has the contradiction between the theory of original perfection in religion, and the accumulated conclusions of archæology, ethnography, experimental psychology, general history, and religious science appeared to me more marked than in the recent work of M. de Pressensé on the "Origins," precisely because the writer in it impartially expounded all the facts acquired or legitimately presumed by contemporary science. He shows that the religious sentiment has been exalting and purifying itself since prehistoric times. Does not the logical conclusion from this seem to be that that sentiment began with most imperfect and gross manifestations? But M. de Pressensé, generalizing from the fact that a confused belief in a supreme divinity is met among some savages addicted to the practices of fetichism, concludes that monotheism was the primitive faith of man. "Because man in his extreme degradation," he says, "tried to find the divine idea and attach himself to it, he must necessarily have possessed it primitively in its grandeur." † M. de Pressensé approaches the problem of our moral and religious origins with the preconceived notion of a fall, of a degradation suffered by mankind for having violated the moral law, during a first trial of liberty. He does not see that this explanation explains nothing, and that it leaves intact the question, how mankind could at first have realized the divine idea in its plenitude—except by causing to intervene at the beginning, as M. de Pressensé seems inclined to do, a supernatural revelation, or by holding with the poet—

"L'homme est un dieu tombé qui se souvient des cieux"
(Man is a fallen god, who has memories of the sky).

* Mr. Max Müller has done me the honor to quote a passage from my lectures on India, in which I brought out the contrast of the ancient Brahmanic philosophy with the idolatry, almost fetichism, with which the stranger's eyes are struck on his arrival in Hindostan. But by this, I in no way intended to maintain that the vulgar practices of Hindooism were a degradation of the Vedic theology, still less that that represented the original and complete condition of the Hindoo conceptions.

† E. de Pressensé, "Les Origines," Paris, 1883, p. 491.

The mind proceeds from the known to the unknown. This is the highway that leads to science, but on condition that the traveler does not wander from it to launch himself into hasty conclusions. The philosophers of the last century, seeking to explain how primitive man fell under the yoke of positive religions, maintained that they were invented by the priests; some added, and by kings. It is true that priests and governments have used religions too much for personal or political interests. But that is no reason for believing that they invented them.

Good sense teaches that the existence of the priest is posterior to the birth of the religious sentiment. Besides this, nothing is more contrary to the tendencies of contemporary science than to regard man as a lump of dough indefinitely plastic in the hands of legislators and mystagogues. Not only is it henceforth averred that all known peoples have religious faiths, in the sense that they admit the existence of superhuman powers intervening in the destiny of the individual, but I shall also have occasion to show that they all possess—at least in a rudimentary state—the essential elements of worship, prayer, sacrifice, and symbols; and that these elements are clad with analogous forms among the most diverse races, and that, wherever we can trace the course of religious evolution, we see faiths passing through phases, if not identical, coming under general laws. Religions make themselves, and are not invented.

From the fact that some kings and heroes have been deified, a few philosophers have concluded that all the gods were deified men. In this way, according to Evémère, among the ancients, the first chiefs or the first sages, having obtained domination by means of their physical or intellectual superiority, have had a supernatural power attributed to them, and have consequently received divine honors. If we had asked this philosopher whence the first believer derived the idea of the supernatural and divine to apply it to kings and priests, he would have been greatly embarrassed to answer us. Evémère's school, resting upon a tradition that Zeus once reigned in Crete, and on the fact that his tomb is shown there, maintained that the master of Olympus was an ancient Cretan sovereign, deified by his subjects. We know now that Ζεύς πατήρ is found among the Romans, the Hindoos, and the Germans, under the names respectively of Jupiter, Dyaus-Pitar, Zio, or Tyr, and with the general character of Heaven-father, the first form of "father who is in heaven." *

Another school obtained a better conception of the real character of the gods, when it associated them with Nature deified in its phenomena. As early as the sixth century before our era, Theogenes of Rhegium declared that Apollo, Helios, and Hephæstos were fire under different aspects—Hera the air, Poseidon water, Artemis the

* M. J. Darmesteter identifies him also with the Ahura Mazda of the Persians and the Svarogu of the Slavs.

moon, and the rest likewise. This was a current opinion among the Stoics. Cicero makes some philosophers, in his treatise "De Natura Deorum," say that the gods recruited either from among the phenomena that strike the imagination, or from among the natural objects that render services to man.*

These views have been confirmed in our days, not only for the Greek and Roman Pantheon, but also for the gods of all known peoples. Only here again we must take account of other theogonic factors. Among the gods there are some who are certainly men or animals deified. Others are derived exclusively from moral abstractions, such as Virtue, Good Faith, Prudence, Fortune, etc., or from metaphysical speculations, like the supreme Brahm of the Hindoos. It should also be remembered that the gods of Nature tend, among some peoples, to become transformed into gods superior to Nature, so that their primitive significance is at last obscured and lost, as Assur among the Assyrians, Ahura Mazda among the Persians, and Jahveh among the Israelites. It was through the failure to grasp these shades that Dupuis, at the end of the last century, wasted his time and learning in maintaining the astronomical significance of all ancient and modern gods and cults.†

We can easily explain how the personification of the celestial bodies and of natural phenomena has led to the representation of their movements and relations as adventures of heroes or of gods. Antiquity had already penetrated the sense of its most transparent myths. But the interpretation of mythology has found its methods only in our own days.

Otfried Müller regarded myths as local legends that translated into a form of personality some particular features of geography or circumstances of history.

Others with Mr. Max Müller have insisted on the solar signification of myths; they have seen in them a reflection of the impression produced on the imagination of infantile people by the periodical succession of light and darkness, of day and night, of summer and winter. Thus, the labors of Hercules are simply the works of the sun during the twelve months of the year. Œdipus personifies the day-star; son of the Dawn, he kills his father every morning; son of the Night, he marries his mother every evening.

Others still, among them Adalbert Kuhn, have set forth that the mind of primitive men was most manifestly affected by the irregular phenomena of Nature and sudden changes of the atmosphere; by this theory the principal myths dramatized the apparent struggles of the sky and the storm, of the sun and the cloud, of the fire and the dark. Developing this view, M. Darmesteter has shown how among the Hin-

* Cicero, "De Natura Deorum," I, 42; II, 23.

† "Origine de tous les cultes, ou religion universelle," by Dupuis, "Citoyen Français, Paris, the Year III."

doos, Persians, Greeks, Latins, and Germans, the story of the creation corresponds with the picture afforded by the apparent new birth of the world after each storm.*

There are those who have seen in myths simple metaphors conceived by poets and taken seriously by their hearers. Thus, when Pindar represents Excuse as the daughter of Reflection, when Prodicus speaks of Hercules as the butt of two women who personify Pleasure and Virtue, they give those images the sense that we ourselves would attach to them; but the figures are taken in earnest by the masses, and so myth arises from metaphor and parable. With still more probability has some confusion of this kind resulted from changes of language, when the appellations of objects personified in this way have lost their primitive signification, and no longer suggest anything but proper names.

Some postulate besides this *auricular* mythology an *ocular* one, holding that the origin of myths should be sought in uncomprehended or badly interpreted drawings. Coins, cups, and primitive objects of art in which emblems, personages, and real or fancied scenes are represented, have set the imagination at work of strangers who acquired them, and they have tried to explain the figures by extemporized legends. According to M. Clermont-Ganneau, the Chimæra and its legend originated in a composition quite common on the Lycian monuments, in which a lion appeared to be devouring a deer. The two animals, if we should suppose them combined by an inexact or ignorant copyist, might in fact give the idea of a monster formed by an amalgamation of the lion and the deer or goat. So the triple Geryon, slain by Hercules, is found among the Egyptian monuments under the form of three men kneeling before a victorious hero.†

According to Mr. Herbert Spencer, the adventures attributed to the celestial bodies and personified phenomena, to the sun, moon, sky, twilight, etc., originally related to human beings bearing the names of those bodies or phenomena as their heroes. Thus, a person who left a living memory among following generations was called Aurora, because he was born at dawn, or for some other reason. Gradually he became confounded with the dawn, and his adventures were interpreted in the way that the phenomena of the nascent day made most plausible. Then, as the same name may have belonged to several persons of different tribes and times, such a juxtaposition of contradictory stories as we find in most mythologies would inevitably have been brought about.‡

My conclusion is that there is truth in each of these theories, and that they do not all exhaust the matter. The law of intellectual development is one, but its combinations are infinite, and to seek to

* J. Darmesteter, "Les Cosmogonies Aryennes, Essais orientaux," Paris, 1883.

† Ch. Clermont-Ganneau, "Mythologie Iconographique," Paris, 1878, pp. 9–12.

‡ Herbert Spencer, "Sociology," vol. ii, chap. xxiv.

bring all the myths under a single process of formation is to pretend to open all doors with the same key. There is no pass-key in mythology.

We have still stronger reasons for being on our guard against seeing myths in everything. Our century has witnessed numerous attempts to reduce, not only the great religious initiators, Moses, Jesus, and Buddha, to myths, but all the persons who have played a considerable part in the traditions of history, from Lycurgus to Charlemagne. A sportive essay has even been made to show that Napoleon I was a solar hero, and sustained by arguments the force of which is hardly exceeded by their wit.*

Even the knowledge that some students have of a particular religion may become a cause of errors. Every one has not the sure glance and the fullness of information that have permitted Max Müller to study the origin of religions "in the light of the religions of India." Read the captivating work on "The Science of Religions," by a writer to whom the Sanskrit antiquities were a kind of family heritage, M. Émile Burnouf. The author sets out to show that "the center from which have radiated all the great religions of the earth, is the theory of Agni, of which Jesus Christ is the most complete incarnation." † This theory, as it is laid down in the Vedas, is nothing else than the scientific doctrine of the identity of the principle of fire and motion, of life and thought. How does the author fill the gap between the Vedic ages and that of the composition of the gospel of St. John? He supposes that this theory, formulated previously to the dispersion of the Indo-Iranians, was transmitted by the Persians to the Jews in captivity at Babylon, and that Jesus, having received it from the latest prophets, communicated it to his disciples, to be divulged only after the formation of the Church. Is it necessary to stop to show that this is simply a hierographic romance?

To still another category of preconceived ideas, calculated to falsify the results of religious criticism, belong the preferences arising from the isolated study of a single science. Such preferences give rise to a natural predilection for the field of investigations we have chosen, and to a tendency to refer to it all the problems we are called upon to resolve. Now, when a student applies the processes of one science to another, he runs a strong risk of erring on the one side by approaching facts with an insufficient method, and on the other by perceiving only the phase corresponding to his order of habitual preoccupations. I will draw my example from the two sciences which have perhaps rendered the most service to the history of religions—linguistics and anthropology.

* This joke has been renewed by some students of Oxford, who have demonstrated, at length and sagaciously, that Max Müller never existed. (See the magazine "Melusine," July 5, 1884.)

† "La Science des Religions," Paris, 1876, p. 259.

Both assume to make hierography a simple province of their respective empires. Sometimes linguists wish to interdict anthropologists from illustrating by comparison myths that do not belong to the same group of languages; sometimes ethnographists and students of folk-lore accuse linguistics of having reduced mythology to a mirage, and, under the pretext that philologists do not agree in their etymologies, deny that they have contributed to the knowledge of myths, even within the circle of the Indo-European languages.* Let us examine the force of these conflicting pretensions:

The comparative grammar of the Indo-European languages is incontestably not sufficient to interpret the myths of peoples belonging to other ethnic groups, or to explain all the mythology of the Aryan peoples. Where myths occur under a form nearly identical among different races, beginning with the uncivilized people of our own epoch, we have a general fact, the source of which should be sought elsewhere than in the language or the isolated history of a particular race. Every one has heard of were-wolves. An explanation of the origin of lycanthropy has been sought in a supposed Greek pun, resting upon the assonance of λύκος, *wolf*, and λευκὸς, *white*. Tradition may have spoken of personages dressed in white; whence a popular legend that they were transformed into wolves. But anthropology disposes of this theory by telling us that among uncivilized peoples very distant one from another, in Asia, Africa, and America, the power is attributed to some men of transforming themselves into wild or dangerous animals, and explains that such a belief flows naturally from the idea that the savage forms of the mutual relations of man and the animal world.†

It is nevertheless true that philology alone can disengage the original sense of some names and some myths from the confusion of gradual changes and parasitical surcharges. How could we have been able to penetrate the myth of Prometheus, or write the real history of Jupiter, without the study of Sanskrit?‡ Sir John Lubbock attempts to explain the origin and attributes of Mercury, or Hermes, by the usage, widely extended among non-civilized peoples, of paying worship to erect stones. These stones, we observe, mark the respective limits of the tribes, are set up in pastures, point out roads, designate the location of markets and intertribal meeting-places, bear inscriptions, and cover tombs. Hence, Mercury came to be regarded as the patron of shepherds, travelers, merchants, and, sarcastically, of thieves, the

* See, in particular, in the "Athenæum" of August 30, 1884.

† "To those who live in countries where wicked people and witches are supposed constantly to assume the form of wild beasts," says Sir A. C. Lyal, writing of India, "the explanation of lycanthropy by a confusion between λύκος and λευκὸς appears utterly idle."

‡ Even Mr. Andrew Lang, who holds to the possibility of accounting for myths without the aid of philology, had to have recourse to it when he came to the Indo-European myths. (See, in the "Encyclopædia Britannica," vol. xvii, p. 153.)

god of games and letters, and the conductor of souls. "He was the messenger of the gods," Sir John Lubbock adds, "because embassadors met at the frontiers; and of eloquence, for the same reason." *

Unfortunately for this explanation, Kuhn has traced the connection between Hermes or Hermias and the two sons of Saramá, the messenger of Indra, who brought back cows stolen by the demon of the storm. They, the Sâramâyau, represented the mythical dogs that guarded the road to the other world and led souls to Yama, the subterranean sun, and king of the infernal regions. Going with the Greeks to the West, one of these personages, named Çarvara, became Cerberus; the other was promoted to be Hermes—personifying the wind or the twilight; and we find in Max Müller that that identification "is one of the guiding threads that have pointed out to science the right road in the labyrinth of the ancient Aryan mythology."

Thus we see how, by this exchange of good offices between linguistics and anthropology, the sciences check and correct, and consequently complement one another, each bringing its contingent to the constantly increasing treasure of our historical knowledge. The sesame of this treasure is, "No exclusiveness, no prejudice."

I have now passed in review the principal forms that have served as the vehicle of the aspirations of the human mind toward the invisible and beyond—from vague adoration of luminous and nourishing force to the highest conception of a God at once spirit, love, and truth —from the worship concerned with ghosts and fetiches to the identification of religion with faith in the moral order of the world. What picture could be presented more varied, more instructive, more capable of attracting those who are occupied at the same time with the modern discoveries of science and the great problems of humanity?

If any are animated with the desire of contending against superstitions (using the word in its etymological sense), they can find no stronger tool than this study with which to sap the foot of clay of all idols.

To those who hold to the religious traditions of their childhood, I believe I have said enough, however much our views may diverge, to reassure their conscience, provided it does not resist the impartial search for truth. At all events, they should meditate on that phrase of Chateaubriand's: "We must not say that Christianity is good because it comes from God, but that it comes from God because it is good." This thesis implies full liberty of examination, comparison, and criticism.

I insist on the importance, were it only from motives of patriotism, of propagating the more exact knowledge of religious facts. The conclusions of history are not alone lessons of truth; they are also lessons of tolerance. The historical study of religions, I repeat, is not being

* "On the Origin of Civilization and Primitive Condition of Man." New York: D. Appleton & Co. 1871. P. 205.

anxious to learn whether this or that cult is true or false, or even whether the religious sentiment rests upon a real or an illusory basis. There, however, is a point of view that wonderfully facilitates the knowledge of religions, while it also seems to comprise the supreme conclusion of their comparative history. It is the thought that, among the "innumerable manifestations of the religious feeling of man, no one possesses the absolute truth, but each one includes a relative truth; that all represent, as the later sages of pagan antiquity had already discerned, imperfect efforts to realize a perfect ideal." Here is a ground on which the enlightened partisans of different religions can shake hands, not only with one another, but also with the pupils of science and the friends of progress.

POSTAL SAVINGS-BANKS.

By Professor D. B. KING.

IT is generally agreed that a system of savings institutions that would be easily accessible to the people throughout the country, give them absolute security for their small savings, and repay deposits at short notice, would, even if the rate of interest were very low, be a great convenience to many people in every community, and a great encouragement to economy and thrift among working-men and people of small incomes. There are many who think that postal savings-banks similar to those which have been in successful operation in Europe and in the British colonies for a number of years would furnish just the sort of facilities for saving that are needed in this country. Many Americans know something of the working of the postal savings-banks in England, where they have been in operation since 1861.

There are now upward of 7,800 of the post-offices in the United Kingdom open, commonly from nine in the morning until six, and on Saturday until nine, in the evening, for the receipt and repayment of deposits. One shilling is the smallest sum that can be deposited. The Government has, however, recently issued blank forms with spaces for twelve penny postage-stamps, and will receive one of these forms with twelve stamps affixed as a deposit. This plan was suggested by the desire to encourage habits of saving among children, and by the success of penny banks in connection with schools and mechanics' institutes. No one can deposit more than £30 in one year, or have to his credit more than £150, exclusive of interest. When principal and interest together amount to £200, interest ceases until the amount has been reduced below £200. Interest at two and a half per cent is paid, beginning the first of the month following the deposit and stopping the last of the month preceding the withdrawal, but no interest is paid on any sum that is less than a pound or not a multiple of a pound. The interest is added to the principal on the 31st of December of each year.

The methods used for the receipt and repayment of deposits are simple and take but little of the depositor's time. One is not limited, in making deposits or withdrawals, to the office in the town in which he lives. If at any time he desires to do so, he may make deposits in other offices, provided he does not go beyond the total sum allowed a single depositor; his accounts will all be kept together in London, and he can withdraw his money on short notice at any office. These provisions for deposit and withdrawal are sometimes a great convenience to travelers and laborers who make frequent removals. The absolute secrecy which is "enforced upon all officers connected with the banks" leads many working-men to deposit their savings with the Government, who could not be induced to deposit their money with private or ordinary savings-banks where their employers might find out that they were laying by money.

Good results almost always follow the opening of one of these savings-bank offices. Numbers of men and women, boys and girls, are gradually induced to become depositors; money that would otherwise be spent in needless indulgence is left at interest with the Government, and habits of thrift and economy are formed. From December 31, 1874, to December 31, 1884, the number of depositors increased from 1,668,733 to 3,333,675, and the deposits from £23,157,469 to £44,773,773. Trust funds and the funds of charitable and friendly societies, for which special provision is made, are deposited in considerable amounts, so that a large number of persons are interested in the banks in this way.

Since the era of the great frauds which led to the establishment of the postal savings-banks, the ordinary trustee savings-banks have been more carefully managed and guarded. While their number has decreased from 653 in 1861 to 411 a year ago, their depositors have not decreased, numbering more than a million and a half, nor have the deposits fallen off. The slightly higher rate of interest which they pay and the prominent and influential persons who are sometimes connected with their management have made them quite popular in some communities. The funds are invested in Government securities and the chances for fraud are slight. The limit to the amount which one person may deposit in the postal savings-banks has prevented their interfering seriously with private banking enterprises. The proposition to extend this limit has been strongly and, thus far, successfully opposed, the opposition coming chiefly from private bankers. It is generally conceded that, without interfering with established institutions to any considerable extent, the postal savings-banks in Great Britain and Ireland have furnished the working classes with excellent facilities for saving, and have exerted a most beneficial influence in promoting habits of economy and thrift.

The English colonies, seeing the good results of the system that has been described, have established postal savings-banks of a similar character. A higher rate of interest is paid—commonly four per cent—and larger sums are taken from single depositors. The Canadian system, which went into operation in 1868, did not make rapid progress for a time, on account of the good institutions already in existence and the small number of offices of deposit. Greater progress has been made recently. The deposits in

June,	1880,	amounted	to	$3,946,000;
"	1881,	"	"	6,208,000;
"	1882,	"	"	9,474,000;
"	1883,	"	"	11,976,000;
"	1884,	"	"	13,245,000.

In July, 1884, there were 343 savings-bank offices and 66,682 depositors. Of the depositors, 1,400, having $4,722,000 on deposit, were supposed to be farmers; 7,850, having $1,422,000, mechanics; 4,270, having $724,000, laborers; 12,000, with $2,350,000 deposits, married women; and 10,500, with deposits amounting to $1,275,000, single women. The accounts are all kept at the head office in Ottawa, to which each postmaster makes daily reports, and from which receipts are sent to every depositor for every deposit that he makes. Although the amounts received have in the aggregate been large, the losses through frauds have been very small.

Influenced by the success of the English system of postal savings-banks, the governments on the Continent of Europe have now nearly all made similar provisions for the investment of the surplus earnings of the people. The Italian system of postal savings-banks went into operation February 29, 1876. A year ago all the post-offices, except ten, were open as savings-banks. The interest paid is three and half per cent. In 1883 there were 1,305,743 deposits made, amounting to 105,582,729.55 lire. These savings-bank funds are loaned to provinces, communities, parishes, and their divisions, or are invested in fundable bonds or other securities. In France the proposal to establish postal savings-banks was frequently discussed, but not adopted until March, 1881, although the ordinary savings-banks had for several years been allowed to use the post-offices as places for the receipt and repayment of deposits. On December 31, 1883, there were 77,430,000 francs on deposit in the French postal savings-banks to the credit of 374,970 depositors. The well known success of school savings-banks, which are now or will shortly be established in all the schools of France, and the economical and thrifty habits of the French peasantry, would seem to indicate a demand for good and generally accessible facilities for the secure keeping of savings. The Austrian postal savings-banks were first opened January 12, 1883. Up to December 31, 1884, they had received in all 3,311,233 deposits, amounting to 64,-763,350 florins. They are well conducted, and likely to prove very successful. The Belgian system has been in successful operation for more than fifteen years; that of the Netherlands was established some three years ago; while Sweden has just followed her neighbors, Denmark and Norway, in establishing similar institutions.

In 1871 Postmaster-General Creswell recommended the establishment of postal savings depositories in connection with the United States post-offices, and two years later he discussed the subject very fully in his annual report. Several of his successors have renewed his recommendation with great earnestness. Hon. Thomas L. James, after referring to and highly approving of these recommendations, said: "It is my earnest conviction that a system of this description, if adopted, would inure, more than almost any other measure of public importance, to the benefit of the working people of the United States." In 1873 Hon. Horace Maynard brought before Congress a bill to establish a national savings depository, but no action was taken. Since then a number of efforts have been made to induce Congress to enact the necessary legislation. The latest of these efforts was made in 1882, under the leadership of Mr. Lacey, whose report from the Committee on Post-Offices and Post-Roads contains valuable information and suggestions on the subject. The bill which Mr. Lacey introduced, and which has recently been strongly indorsed by the State Charities Aid Association of New York, and other advocates of postal savings-banks, provided that none but money-order offices should receive deposits; that no single deposit should be less than ten cents or more than one hundred dollars; that no one person should deposit more than one hundred dollars within thirty days, or have at any time more than five hundred dollars to his credit; and that interest at two per cent should be paid on all sums over three dollars and multiples of one dollar, beginning the first of the month following the deposit, and stopping the last of the month preceding the withdrawal.

Would such postal savings-banks be more convenient and accessible to the masses of the people than existing institutions and organizations which undertake to safely keep the surplus earnings of the people? Would they furnish better security for deposits and greater encouragement to thrift? Could the Government, without interfering with existing institutions and without loss to itself, carry on this savings-bank business? Would the benefits resulting from properly conducted postal savings-banks be sufficient to justify the necessary extension of the functions of our Government and the increase in the number of our civil servants? These are the chief questions to be considered in deciding whether or not it would be wise for the Government to undertake to keep securely the small savings of the people.

There are in this country a number of institutions and organizations which undertake to persuade poor people to form habits of thrift, and to so invest portions of their earnings as to make some provision for the future. Mutual benefit societies are among the oldest of these organizations, and are very numerous. Some of them confine their operations mainly to giving temporary relief in time of sickness or misfortune, or on the death of their members; others have become practically co-operative life-insurance companies. The sums annually paid into these organizations are in the aggregate astonishingly large. None of these societies, however, enable their members to accumulate capital, and many of them are very unstable and unreliable. The better class of them is not accessible to the masses of the people.

Co-operative societies for production and distribution are not numerous in this country. Many co-operative enterprises have been started, but most of them have failed. The interest in such enterprises seems to be increasing, but at present they furnish but few of our working-men with opportunities for the investment of their surplus earnings.

Building and loan associations have done excellent service in some parts of the country by encouraging persons of small incomes to save money and to invest it in houses for their families. In some parts of Pennsylvania these associations have been particularly beneficial. Large sections of Philadelphia, and of some of the smaller cities of the State, have been built up by them, and thousands of working-men have been led to save portions of their wages, and enabled to own their homes through their agency. In some parts of the country, however, they have not been so well managed, and poor people have sometimes suffered loss and hardship in consequence. These hardships and losses have created great distrust of these associations in some communities. Excellent as is the service which they do, they do not furnish facilities for saving which are available for all classes of the people, nor, with their liability to careless or dishonest management, do they furnish anything like an absolute security for money. The necessity of making regular payments to them and to the mutual benefit and co-operative insurance societies is sometimes an additional incentive to economy, but in other instances it is productive of inconvenience and hardship.

The ordinary savings-banks have furnished all classes of the people in some parts of the country with good facilities for saving small sums, and have especially encouraged habits of thrift among the poorer classes. In 1882 there were in the entire country 667 savings-banks, the average deposits of which amounted to $1,003,737,087. At that time the New England States and New York together had about eighty-one per cent of the savings-banks, and eighty-three per cent of the savings-bank deposits of the entire country.

The New England States are, on the whole, fairly well supplied with savings-banks, having, on the average, one for every ten thousand of the population. In some of these States the banks are so distributed as to be easily accessible to most of the people; in others there are many communities which are inconveniently remote from any savings institution. Outside of New England, none of the States are well supplied. Even New York, with its one hundred and twenty-seven banks, contains large sections of populous country in which there is not a single savings-bank. The other States are still worse off. In 1882 there were in the Southern States only nine, and in the Western States, outside of Ohio, Indiana, and California, only twenty-one savings-banks. Pennsylvania, with its great manufacturing and mining industries, employing regularly several hundred thousand laborers, is very badly supplied. A few years ago there were a number of savings-banks doing a large business in various parts of the State. Many of these were loosely or dishonestly managed, and their affairs were wound up, sometimes with loss to depositors or stockholders, or both. There still exist a few old and perfectly sound savings institutions, and there are, besides, many private banking concerns which receive large sums of working-men's earnings, but, on the whole, the lack of facilities for the secure investment of small savings is deplorable.

Where the population is dense and conveniently grouped about a number of centers, as is the case in some parts of New England, the ordinary savings-banks may be made to furnish adequate facilities for the small savings of the people. Most sections of this country are, however, rather sparsely populated, and it would not be possible to maintain a good savings-bank in every small town. Some of the savings-banks have been so well managed and are so strong that it would be hard to find better security than that which they offer. In general, the savings-banks of New England have been well managed. Occasionally there has been bad management, and general financial depression has brought disaster upon some of them. Three out of every eight of the savings-banks of Maine suspended between 1872 and 1879. While the losses to depositors were probably less, as a rule, than those sustained by men who had invested their money in land or other securities, the value of which shrank greatly during those years, still these suspensions greatly impaired the confidence of the people in the stability of savings-banks. New York has some very solid savings institutions. The losses, however, to depositors from the failures of twenty-two savings-banks in that State between 1872 and 1879 amounted to $4,475,061. These losses have led many people to distrust perfectly sound institutions. In some parts of New York, New Jersey, and Pennsylvania great hardship and suffering have been caused by savings-bank failures, and great distrust and discouragement have followed.

None of these organizations or institutions, excellent as they may be, furnish the masses of the people throughout the country with convenient facilities for depositing their savings, nor do they, as a rule, give anything like an absolute security for the funds intrusted to them. There are, moreover, some large sections of the country in which there are no facilities whatever for the safe-keeping of surplus earnings.

Postal savings-banks could easily be made accessible to all the people. There is in every town a post-office, generally conveniently situated, open all day, and visited by many of the people. All classes are accustomed to intrust their letters, and perhaps their money or property, to it. A depository for savings in this office would certainly be accessible to the whole community. A Government guarantee for the money deposited would furnish the absolute security that is needed to encourage the people to intrust their surplus earnings to such savings depositories.

Whether the Government could conduct such institutions without loss to itself, or injury to private enterprise, or the unsafe enlargement of its functions, is a question in regard to which there is some difference of opinion. Perhaps the greatest difficulty would be that of finding some safe, permanent, and profitable use for the money deposited. Many hold that, if the Government should only guarantee the repayment of deposits without interest, large numbers of the people would gladly place their surplus earnings with it for safe keeping. However this may be, a low rate of interest would add much to the popularity and attractiveness of the arrangement. Two per cent has been suggested as a rate that would be attractive to depositors without interfering much with private banking enterprises, provided the sums taken from individual depositors were not too large. It is estimated that the cost of management might, for the first few years, reach three fourths of one per cent. It would be much more likely to fall considerably below than go above this limit. The problem before the Government, then, would be to safely invest the deposits at two and three fourths per cent.

The European nations which have postal savings-banks, with two or three exceptions, have large national debts, which are not likely to be paid off for centuries to come. The investment of small sums by large numbers of the people in Government securities greatly increases the loyalty of the masses and their interest in governmental affairs. The Government thus borrows at a low rate, and an incidental result of its so doing is to render its citizens more thrifty, independent, self-respecting, and loyal. It is certainly an open question whether the policy of rapidly paying off our national debt, when it could be refunded at so low a rate, is wise. Apart from the necessities of the national banking system, there is a great deal to be said in favor of allowing the principal to remain for an indefinite period when the masses of our laboring-men and poorer classes would gladly take the greater part of the loan at two and three fourths per cent, or perhaps even at a lower rate, and be greatly benefited by so doing. The adoption of such a policy would not necessarily involve the abandonment of the policy of protection. The removal of a portion of the internal revenue taxation would accomplish the necessary reduction of the income of the Government. Of the $348,519,869.92 receipts of the Government for last year, $195,067,489.76 were from customs, $121,586,000 from internal revenue, and the remainder from other sources. Prominent men of both parties are now vigorously advocating a reduction of the burdens of taxation, and, notwithstanding the battle between the free-traders and the protectionists, the general demand for relief will no doubt lead to the adoption of some measure that will cut off the unnecessary revenue. It is evident that the adoption of such a measure can not be delayed many years.

Besides national securities, State, county, and municipal bonds would be available for investment by the Government. Many doubt the wisdom of investing in these, because such securities have in so many instances proved unsafe. The bonds, however, of a number of the States and cities are now considered, by those who are accustomed to invest large sums of trust funds, very nearly as good as Government bonds. If the Government should offer to loan the deposits at two and three fourths per cent, numbers of States, counties, and cities which now pay a much higher rate would be glad to refund portions of their debts, and, in consideration of the very low rate of interest, would doubtless be willing to so draw the bonds that in case of default the Government would have no difficulty in enforcing payment. It would of course be necessary that the investments be made with the greatest care, and that those who have the making of them should possess the confidence of the people in a high degree. The good results that came from the Freedman's Bank when it was wisely administered, and the deplorable effects of the loose management of its affairs in the later years of its existence, would serve as valuable lessons for the conduct of Government savings-banks.

For many years our post-office management has been rapidly growing more and more efficient. Perhaps at the present time no great business is managed more efficiently and economically. There is every reason to believe that still further improvements will be made. Every one is so directly interested in cheap postage, and in the sure and quick delivery of the mail, that inefficiency or dishonesty in the Post-Office attracts attention more quickly than in any other department of the Government. Our rates of postage are now as low as those of Great Britain, although we are compelled to maintain several times as many offices and miles of mail-routes in proportion to the quantity of mail-matter as the latter country. It is scarcely conceivable that, with so strong a public sentiment in favor of honest and efficient civil service, any Administration for partisan reasons would dare to substitute to any considerable extent dishonest and inefficient men for those whose ability and integrity have been tried and proved. It would be suicidal in any party to pursue such a course in a department of the Government which reaches and interests so much all classes of the people. The popular interest in its being well managed would be greatly increased if large numbers of the people were in the habit of intrusting their small savings to it for safe-keeping. The new duties and responsibilities would make the demand for the appointment of honest and capable officials even greater than it is at present, and would, therefore, promote the cause of civil-service reform. The additions to our civil-service list required by reason of such an addition to the functions of the Government would be comparatively few. The Post-Office Department, by means of money-orders and postal-notes, now transmits large amounts of money from office to office. Postmasters and clerks are, therefore, in the habit of receiving and paying out many small sums of money, of keeping detailed accounts, and of making frequent reports. No very great modification of the machinery now in use would be needed for conducting a system of savings depositories in connection with the money-order offices. Occasionally a little more office-room, and another clerk or two, would be needed, but the additions would be comparatively insignificant. The new business would require the same sort of talent and skill as that needed for the issue and payment of money-orders and postal-notes. We might afford to run the risk of whatever danger may come from such an enlargement of the functions and patronage of the Government if postal savings-banks would really prove a great boon to the masses of our people.

Post-office savings-banks would probably not seriously interfere with private banking institutions unless a very high rate of interest were paid and large sums were taken from single depositors. While occasionally deposits would be withdrawn from the ordinary banks and left with the Government, it would probably happen more frequently that poor people who now have no bank accounts would be induced to save some of their earnings, and would in time become capitalists and patrons of national or private banks. In 1873 Mr. Creswell strongly urged that a system of postal savings depositories would not only strengthen our national finances, by bringing large sums into circulation, but would indirectly afford our monetary and banking institutions "the very relief" of "which they stood in need."

It goes without saying that many American working-men are frugal and save considerable portions of their earnings. Evidences of their economy and thrift are seen in the large numbers of capitalists who began life as laborers, and in the thousands of comfortable working-men's homes which the owners have built or bought with their savings. It is evident, however, that great numbers who might live comfortably, and at the same time save enough to make them independent in sickness or old age, and to give their children a fair start in life, spend all their earnings, and are never far from want. The average American laborer is apt to be too generous and open-handed, spending his hard-earned wages recklessly for the gratification of his momentary desires or fancies. Such a man is liable to be largely at the mercy of his employers. Although wages may be at starvation-point, he can not take his labor to a better market elsewhere. When times are hard, he and his family are likely to suffer. If the great majority of our working-men could be persuaded to save something, however small the sum, each week, the habits of economy and thrift thus acquired would be a great gain to the nation : pauperism and crime would decrease ; the comfort, self-respect, and independence of the people would increase ; and there would be fewer interruptions to the business and industries of the country growing out of troubles between laborers and employers, for the laborers would become more steady, trustworthy, and independent, less liable to rush recklessly into strikes, and would be less at the mercy of an unfair employer.

Were a system of postal savings-banks established and well conducted, there is no doubt that large numbers of our laboring classes would soon become depositors of small sums. Many working-men now have great difficulty in keeping securely money which they wish to save ; others often spend all their earnings for drink or the gratification of their whims or fancies, when they would not do so if they had some perfectly safe and convenient place to deposit the money where it would bring them a little interest, and the fact of their having it be kept a secret. The masses of the people have the greatest confidence in the Government, and would gladly intrust their small savings to its keeping, provided such a system of savings depositories were devised, with such men in charge of it as would command their confidence. It is a question whether at the present time our Congressmen could do so much for the working-man in any other way as by providing him with this means of helping himself.

THE REFRACTING TELESCOPE.

By CHARLES P. HOWARD.

THOSE who have looked through a large telescope under favorable atmospheric conditions, at one of those immense cyclones which occasionally break out on the surface of the sun, have derived from what they saw a very good idea of the origin of sunlight. They have seen that the brightest portion of the surface of the sun consists of columns of intensely hot metallic vapors, averaging about three hundred miles in diameter, rising from its interior and glowing with extreme brilliancy, from the presence of clouds formed, probably, of shining particles of carbon precipitated from its vapor as the tops of the columns reach the surface and lose heat by expansion and radiation. (A good idea of such a precipitation is had by observing the particles of water condensed from transparent vapor, in unusually high thunder-heads, where the action is in some respects similar.) Between these ascending columns are seen descending masses of cooler vapors, rendered dark and smoky by relatively cool and opaque particles of carbon, all or most of the other elements being still maintained by the excessively high temperature in the condition of transparent vapor. In the immediate region, however, where the cyclone is raging, these bright ascending columns are drawn out horizontally by the inrushing metallic winds (which often reach a velocity of a thousand miles per hour) into long filaments, pointing in general toward the center of the disturbance, which is always occupied by a huge black cloud of smoke (frequently twenty thousand miles in diameter) rapidly settling back into the interior of the sun. Over and across this great central black cloud are often driven long arms of the shining carbon-clouds, which, when the cyclonic action is very strong, bend round into slowly changing spiral forms, very suggestive of intense action. A striking illusion, invariably connected with this sight, is that the observer seems to be viewing it from a position quite near the scene of the disturbance, whose minute and complicated details are seen with exquisite distinctness.

After witnessing such a spectacle, the observer must have felt great admiration for the men who have devised and successfully constructed an instrument capable of showing in action such enormously energetic forces, the very existence of which would otherwise hardly have been conceived.

But, although the refracting telescope has now been brought to such exquisite perfection, the first ones were exceedingly crude, and it is interesting to trace the gradual development of the telescope from a simple pair of spectacle-glasses, suitably placed one behind the other, into the great refractors of Washington, Vienna, and Pulkowa, which are monuments of optical and mechanical ingenuity.

Spectacles were invented about the year 1300, but it was not until 1608 that a Dutch spectacle-maker, as a pretty experiment, combined two such lenses in a way that made distant objects look nearer. A rumor of this invention reached Galileo, at Venice, in 1609, and interested him so much that, before he had even seen one of them, he reasoned the problem out for himself, and in a few days produced a telescope which made distant objects appear to be only one third as far away as they actually were, by cementing a suitable spectacle-glass in each end of a lead organ-pipe. With this instrument the astonished senators of Venice derived great amusement in spying out ships at sea from the top of the great bell-tower.

So industriously did Galileo follow up his first achievement, that soon he had constructed more than one hundred telescopes of various sizes, one of which made objects look eight times nearer ; and, finally, with great exertion and expense, completed one magnifying thirty diameters, which we now know to be the greatest power possible with the form of lenses that he used, viz., a double-convex lens for the object-glass and a double-concave lens for the eye-piece.

With such crude instruments as these, Galileo made his well-known discoveries, which, coming just when they did, proved of great importance in giving an additional impulse to the then rapidly awakening intellect of Europe.

Soon after the death of Galileo the telescope was further perfected by Huygens, who, in the first place, invented the form of eye-piece which still bears his name, and gives a large, flat field with very sharp definition. Many variations of form, but no improvement in the seeing quality of telescopic eye-pieces, have since been made, so that from this time all improvements in the telescope have been necessarily confined to the object-glass.

Huygens next enlarged the single-lens object-glass to its greatest possible power. His largest telescope had an object-glass five inches in diameter, and a focal length of one hundred and twenty feet; this enormous focal length being absolutely necessary to reduce the blurring effect of the prismatically colored fringes, as well as spherical aberration, to such moderate limits that a magnifying power of upward of two hundred diameters could be employed.

To have watched Huygens at work with this telescope must have been an amusing sight. Its great length precluded the use of a tube, and therefore an assistant was obliged to slide the object-glass up and down a vertical pole, one hundred feet high, by a cord, while Huygens pointed the eye-piece at the object-glass by sighting along a string connecting the two, meanwhile steadying himself by resting his elbows on a two-legged wooden horse. A more difficult and unsatisfactory contrivance to use can hardly be imagined, yet, with this telescope, in 1655, he discovered the rings of Saturn, and one of its satellites.

Newton, about this time, hastily concluded, from experiments of his own, that refraction without prismatic color was out of the question, and that the refracting telescope was incapable of further improvement; he therefore abandoned the study of the refracting telescope, and turned his attention to the construction of reflectors, and thus narrowly escaped making that most important discovery—the achromatic object-glass—which, only two years after his death, actually was made by Dollond, who, in 1757, constructed one two and a half inches in diameter, corrected both for prismatic color and spherical aberration.

From that day the power of the refracting telescope rapidly increased, and up to the present moment has only been limited by the ability of the glass-makers to furnish large pieces of optically perfect glass.

The completely equipped telescope, with its object-glass and mounting, aside from being a triumph of the highest optical and mechanical skill, is certainly the noblest instrument that man has yet constructed, and it is difficult to decide which is the most sublime and elevating to contemplate—the universe, which the telescope enables us to see, measure, weigh, and, combined with the spectroscope, to analyze ; or the exquisite mechanism, by means of which light is first originated, then propagated, and finally refracted to an image on the retina of the eye.

We shall, in what follows, briefly consider the latter subject, which will enable us to understand the natural laws that render possible the remarkable degree of perfection and power to which the refracting telescope has been carried, and which also fix a limit to its indefinite improvement.

Light is the sensation produced on the retina of the eye by some *force*, usually emanating from a luminous body, but not always, for the same sensation may also be produced by a current of electricity, or by a quick blow on the ball of the eye.

At the first glance this force, which has such a remarkable effect upon the retina of the eye, seems to be a rather difficult thing to interrogate in a way to make it divulge something of its true nature ; and so it really proved, for even Sir Isaac Newton, with all the facts known in his day, and with the splendid work of Huygens on the undulatory theory of light before him, failed to satisfy himself on that point ; and, in fact, it required the combined work of Young, Fresnel, and many others, extending over a period of two hundred years, to demonstrate beyond question that the one and only explanation admissible is the undulatory theory first propounded by Huygens.

At the present time, however, it is possible to state with certainty a great deal regarding the true character of this force called *light*.

A revolving mirror, properly combined with one that is stationary, shows that light travels between them through a vacuum with the almost inconceivable velocity of 186,000 miles per second ; while other experiments prove that this is also the velocity of light through space from star to star.

The diverse and curious phenomena called diffraction, interference, and dispersion, show that light consists of vibrations or waves in some transmitting medium, and therefore that this medium must fill the whole visible universe.

The phenomenon called polarization of light shows that the motion of each particle of the medium as it vibrates is at right angles to the direction in which the waves are propagated, and, strange to say, that the medium transmitting them has the properties of a solid substance, and not those of a fluid, such as a liquid or a gas. A good idea of this kind of a wave is had by observing the wave propagated along a tightly stretched telegraph-wire when it is struck a smart blow with a stick. Although many of the properties of the light-waves are also common to all forms of wave-motion, yet others are distinctively due to the waves being of this particular kind. This form of wave, therefore, is to be carefully distinguished from that propagated in a fluid, where there is always a forward and backward motion to the particles. For example, in the familiar case of waves on the surface of water, the particles of water move in circular paths as the waves pass by—that is, each particle moves forward and back exactly as far as it moves up and down. Also in the case of sound-waves, which are waves propagated through a gas, the particles of the air move only forward and back along the line in which the sound-waves are advancing.

The diffraction grating shows that the waves which produce the sensation of light are very minute, and are of every possible length, between the limits of 32,000 to the inch to 64,000 to the inch, measured from crest to crest. This is only one fifth of the total range of wave-lengths that have been measured radiating from the sun, but only those longer than $\frac{1}{32000}$ of an inch, or shorter than $\frac{1}{64000}$ of an inch, ordinarily reach the retina to produce the sensation of light. The diffraction grating also shows that the color of light is due directly to the length of the waves, the longest producing the sensation of red light, the shortest of violet, while ranged in between come the various shades of orange, yellow, green, and blue.

Diagram 1 will perhaps give a better idea of the true size and number of the light-waves than is possible from a mere statement of their length and velocity in figures. It represents in section, magnified five hundred diameters, a series of crests of the longest waves that affect the eye as light, passing through a hole in writing-paper, pricked by an ordinary No. 12 sewing-needle, measuring one seventy-fifth of an inch in diameter. It will be noticed that, although the magnified diameter of the hole appears nearly seven inches across, yet the equally magnified crests of the light-waves are still only just far enough apart to be distinctly separated by the eye. On this scale the pupil of the eye would appear nine feet across, and a very good idea of the number of these particular waves, which enter the eye in a continuous stream whenever it receives the light of a distant object, can be had by considering that, if every one of these light-waves passing through the needle-hole in a single second had been represented on the diagram, one behind the other, they would have formed a band extending in the direction of the arrow to a distance of nearly 100,000,000 miles, and to have shown them all on the diagram would have necessitated the paper being long enough to reach from the earth to beyond the sun!

Having once established the fact that the sensation of light is caused by waves originated in the sun and stars, falling upon and irritating the retina of the eye, it of course follows that space must be

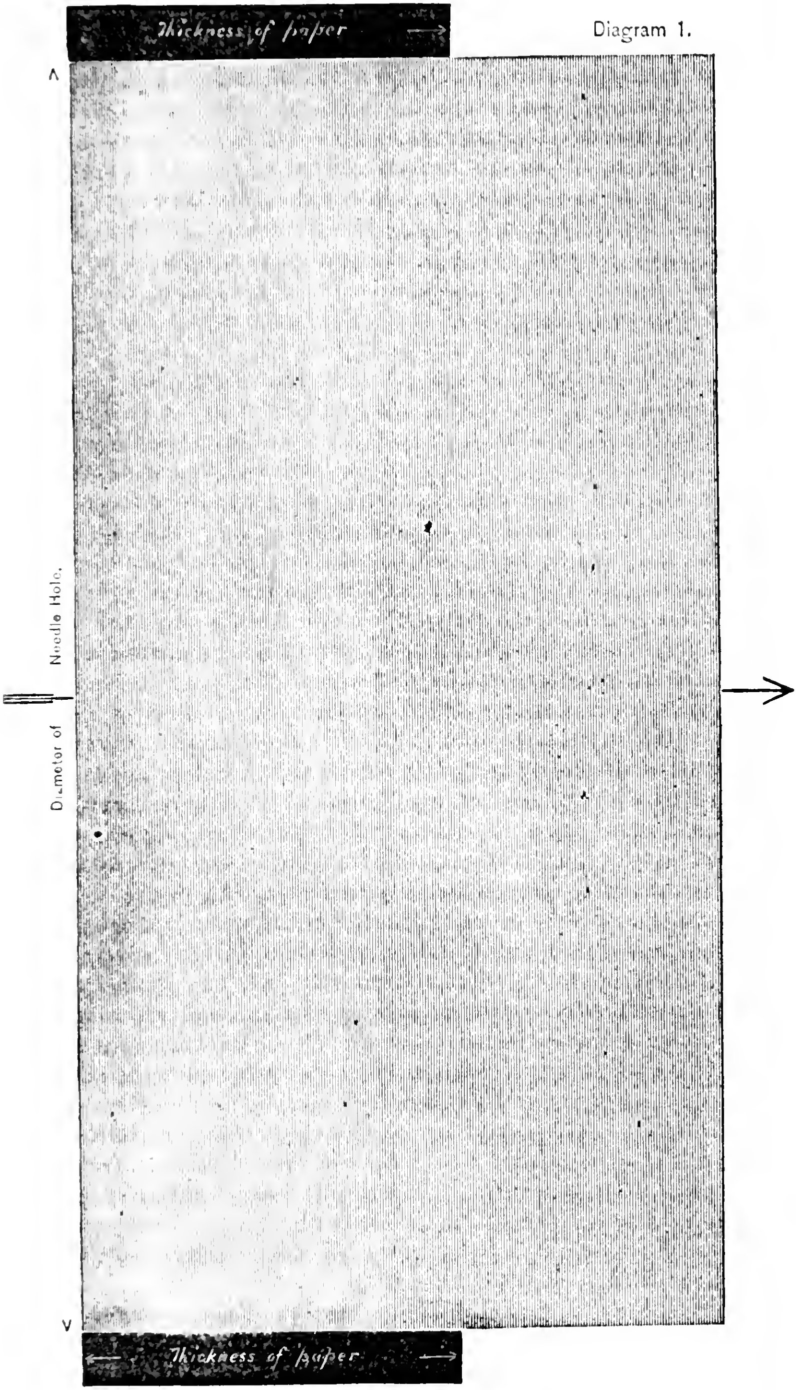
Thickness of paper
Diagram 1.
Diameter of Needle Hole.
Thickness of paper

DIAGRAM 1.

filled with some substance having, as we have already seen, the properties of a solid. Now, although it is easier to conceive that all space is filled with some kind of substance than to conceive it to be empty, in order to account for universal gravitation, it is at least unexpected that this substance should turn out to be a solid, yet the polarization of light shows that a solid substance it must be, notwithstanding the fact that the planets rush through it without the smallest apparent resistance.

But even this anomaly is not utterly inconceivable, for many familiar substances have at one and the same time the properties both of a solid and a liquid—for example, pitch, rosin, and tar. We would all probably consider pitch as quite a brittle solid, yet it is at the same time a perfect liquid, as an incident that happened to Alvan Clark will illustrate. He once opened a new barrel of pitch, using a hatchet to crack off some for use in polishing lenses; after breaking off enough for his purpose, he laid the hatchet down on the pitch which nearly filled the barrel, and thought no more about it until some few weeks afterward, when the hatchet could not be found, although he distinctly remembered having left it lying on the opened barrel. He thought it stolen until about two years afterward, when the missing hatchet was discovered at the bottom of the pitch, having sunk into it, clear to the bottom, leaving no hole behind, just as a stone would sink in water, only of course much more slowly.

All who have worked with pitch know that it has the property of being a slowly moving liquid; and it is evident that *this* particular kind of substance at least is a solid to one kind of motion, such as the quick blow of a hatchet, but is a liquid to another kind of motion, such as the steady pressure of a hatchet slowly descending through it. That is, give it plenty of time to flow, and pitch is a perfect liquid; but hurry it, and it is a very brittle solid.

Now, this strange substance which fills all space seems to possess this peculiar double property in a vastly greater degree than does common pitch, for we find that to such a quick motion as a vibrating molecule it acts as a most rigid solid, but to the comparatively slow and steady motion of a planet it acts as an inconceivably thin liquid, allowing the planet to pass through with no apparent resistance.

This remarkable substance, which fills both intermolecular and interstellar space, is called the universal ether. Its properties are only beginning to be learned, and will not probably be well understood until such phenomena as gravitation, electricity, magnetism, and the peculiarities seen in the tails of comets, are satisfactorily explained. A statement, however, of a few of its observed properties is a necessary prelude to a complete understanding of the telescope.

The molecules of ponderable matter are supposed to be inclosed in the ether, just as a wooden ball could be incased in the center of a large block of jelly. The waves of light are supposed to be originated by the vibration of the molecules, in somewhat the same way as the jelly might be agitated: by vibrating the wooden ball in its center, each molecule as it swings sends an impulse or vibration through the ether, which, traveling with equal velocity in all directions, forms as a whole an expanding spherical wave-front, in shape like a quickly blown soap-bubble, having the vibrating molecule at its center.

The molecules of a hot body are in a state of intense vibration, and, each being suspended in the substance of the ether, originate in it a steady succession of these spherical wave-fronts, which, by one of the fundamental principles of wave-motion in an elastic medium, do not interfere with each other in the least, but each set of waves goes straight on, as if every one of the other sets were not in existence.

When light passes through a transparent substance, such as glass or water, it is propagated, not by the vibration of the molecules of the substance, but by the vibration of the ether in which the molecules are as it were submerged. This is proved by the enormous velocity with which the vibrations are propagated within the substance, which is immeasurably greater than the elasticity of the substance can account for. There are also other phenomena which lead to the same conclusion, but which it is not necessary to allude to here.

It has been found by direct measurement that the velocity of the light-waves is less through transparent bodies than through space. For some reason, the ether acts as if it were heavier within the body than outside of it, being apparently condensed by the presence of the molecules; and the velocity of the waves is lessened by their passage between the molecules of the transparent body, so as to produce an effect similar to that produced on the velocity of waves on the surface of water by the nearness of the bottom, where their velocity diminishes rapidly as the water grows shallower.

Upon this simple fact, that the light-waves progress with less velocity through transparent solid bodies than through space or air, depends the complete explanation of the telescope.

But, before considering the effect of this retardation of the light-waves by their passage through transparent bodies, it is well to get a definite idea of a wave-motion by observing one that is visible to the eye. This can be beautifully done by the elliptical tank of mercury roughly shown in Diagram 2—the velocity of waves on the surface of mercury being slow enough to be easily followed by the eye.

The rim of the dish is elliptical; the little ball to originate the waves is constrained to vibrate at one focus of the ellipse, and it will be observed that each time the ball makes a vibration a circular wave-front, convex toward the direction of its motion, spreads out on the surface of the mercury from the ball as a center, until, meeting the elliptical wall of the dish, it is changed by reflection to a circular concave wave-front, which converges to its center, where the agitation of the surface is much greater than anywhere else; and, indeed, if the mercury were perfectly elastic, as is the ether, the agitation at the center of the completely circular concave wave-fronts would be as great as at the origin of the disturbance.

We also see, from this experiment, that circular wave-fronts travel in a direction at right angles to the direction of their fronts, so that, if

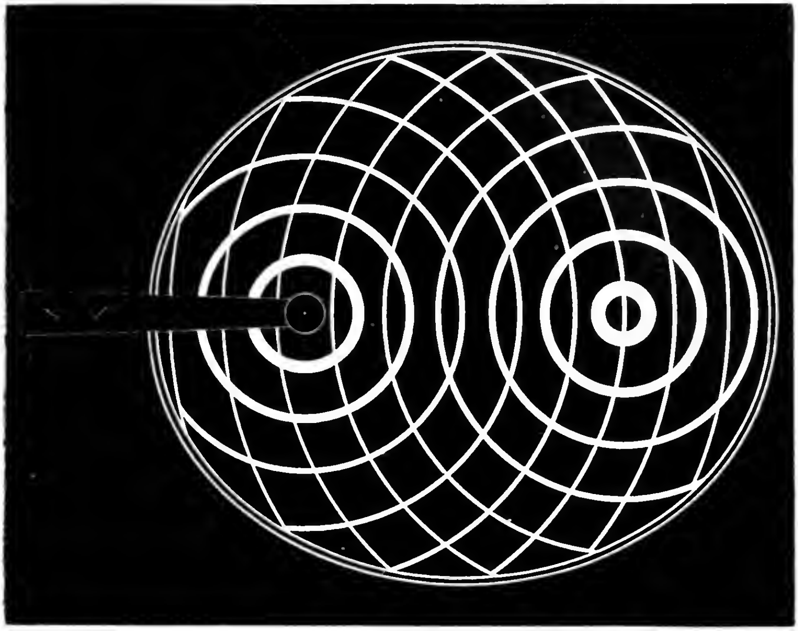

DIAGRAM 2.

from any cause a wave-front becomes circular and concave toward the direction in which it is moving, it will run to a perfect center or focus, and at that particular place create a comparatively great disturbance. By locating the vibrating ball at random on the surface of the mercury, it will also be seen that, unless the concave wave-fronts are truly circular, they will not run to a single point of great agitation, but only a confusion of cross-waves will result.

The same phenomena of wave-motion made apparent to the eye on the surface of the mercury are also true of light-waves: if from any cause the wave-fronts become spherical, and at the same time concave, toward the direction in which they are moving, they will also run to a center, and cause intense agitation at that particular point, but nowhere else.

Diagram 3 represents the effect produced upon the light-waves diverging with uniform velocity and spherical fronts, from a vibrating molecule, by passing through a transparent body, whose faces are surfaces of revolution elliptical in section, called a lens. As already stated, the light-waves are retarded during their passage through the body, and it is plain that the central portion of each wave-front will be retarded more than the marginal part, having a greater thickness to pass through, so that the central part will lag back; and, when the wave-front emerges, its form will have become concave, instead of convex; and as, with the

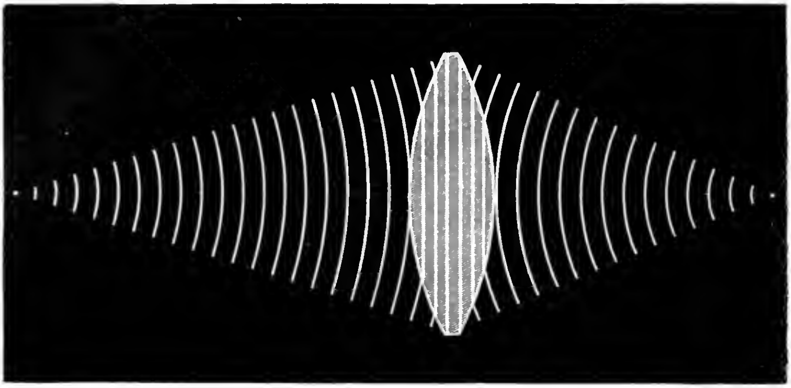

DIAGRAM 3.

particular form of lens that we have assumed used, its form will be spherical, each wave will run to a center or focus, and create there a great agitation.

Now, the same thing exactly will happen if the vibrating molecule is removed to an indefinitely great distance, as for instance to one of the stars: in this case the wave-fronts will be sensibly plane, on account of the distance of the center of curvature, just as the surface of water standing in a pail is sensibly plane, although the center of its curvature is only four thousand miles distant.

It is found experimentally, or it can be demonstrated mathematically, that the vibrating molecule, the center of the lens, and the focus of the emerging concave wave-fronts, lie in a straight line; with this fact distinctly in mind, it is clear that a second vibrating molecule, say, situated in another star, in nearly the same direction from the earth as the first, will also form a second center of agitation or focus, exactly behind the center of the lens, as viewed from that star; and so on from any number of vibrating molecules, each and every one producing a different center of agitation, exactly behind the center of the lens as viewed from them, of course within reasonable limits on each side of the direction of the axis of the lens.

We are now in a position to understand clearly the reason why we are able to see distinctly the forms of distant objects.

Diagram 4 represents the lens of the eye, with plane wave-fronts of light, from two different vibrating molecules, situated in different stars, entering it, and running to a focus or center of intense vibration behind it. The short lines at the back of the eye represent the so-called rods of the retina; when one only of these rods receives

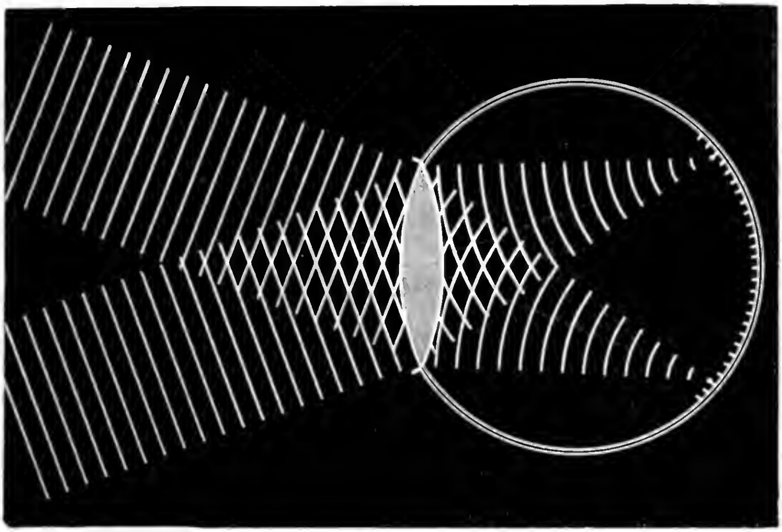

DIAGRAM 4.

a shock, the sensation of a point of light is produced. As shown in the diagram, just one rod is agitated by each set of waves, so that the eye sees in this case two distinct points of light, the brilliancy of each depending upon the intensity of the agitation. A third vibrating molecule in another star would be seen by the eye in the same way, and so on indefinitely.

As the color of light depends merely on the wave-length, we can now understand how the eye sees the constellations in their true configurations and colors; and, as reflected light has the same effect on the eye as that coming directly from self-luminous points, it is plain that the eye must see the form and color of all luminous objects, each individual point of each object forming its own focus on one of these sensitive rods of the retina.

Can any mechanism be more simple and beautiful than that of vision? The more it is studied the more admirable it seems, and we are in a still better position to appreciate the elegance of the mechanism which enables the lens of the eye to form a perfect image of distant objects upon the sensitive retina, when we take into consideration the fact that, were the waves of light not so excessively minute, distinct vision would be utterly impossible.

It is only because the light-waves are so much smaller than the aperture of any lens, such as the lens of the eye, that they run to a focal point, instead of spreading out in all directions, as do the waves of sound which enable us to hear round a corner. The effect of decreasing the aperture of the lens of the eye to a size comparable with that of the light-waves (which would in effect be the same as increasing the length of the light-waves to a size comparable with that of the eye) can easily be shown thus:

The first diagram exhibits the comparative size of a hole one seventy-fifth of an inch in diameter, and the longest light-waves. If we limit the aperture of the eye to this size, by holding a sheet of writing-paper before it, with such a needle-hole pricked in it, and look through the hole at a luminous point, such as a distant electric light, instead of seeing it as a point of light too small to have a visible surface, as we should expect, we will see instead quite a large disk of light surrounded by one or two bright rings as illustrated in Diagram 5.

Diagram 5.

This peculiar appearance is caused by the spreading of the light-waves, after passing through the needle-hole, so that, although the wave-fronts are spherical as they emerge from the lens of the eye, yet at the distance of the retina they have spread out sidewise so much that, instead of running to a point, they cover a surface large enough to be distinctly perceived as a luminous disk. It can be proved mathematically by the theory of undulations, that the diameter of this luminous disk, measured in seconds of arc as viewed from the center of any lens, for light-waves, having a length of about $\frac{1}{50000}$ of an inch (the brightest and central part of the normal spectrum), will equal four and a half divided by the number of inches in the clear aperture of the lens, its size, however, increasing or diminishing a very little, according as the light-waves are longer or shorter.

Objects viewed through such a small hole appear very indistinct, from the image of each point overlapping those of its neighbors. The same defective vision would have resulted had the light-waves been created less minute than they are, or of a size comparable to the diameter of the pupil of the eye.

It is also on account of the extreme minuteness of these waves that light appears to travel in rays, and that opaque bodies throw sharply defined shadows.

Returning to a simple lens of considerable diameter, as shown in Diagram 6, and still assuming it to have spheroidal surfaces so that the emerging wave-fronts shall be spherical, and considering the light-waves to be originated by a single vibrating molecule situated at an infinite distance, we come to a peculiar phenomenon, also a result of the excessive minuteness of the light-waves, and the consequent tendency of light to move in straight rays. After the emerging waves have run to a focus, they diverge again from this focus as a new center, with spherical fronts, and in exactly the opposite direction to that from which they arrived, just as if the light emerging from all parts of the lens was propagated through and beyond the focus in straight lines; hence the marginal portion of the converging and diverging wave-fronts on each side of the focus will form two cones, turned in diametrically opposite directions, their common apex being the common center of the spherical wave-fronts, viz., the focus of the lens.

It is now evidently a simple matter to place a second lens at such a distance behind the focus of the first lens that it will transform the spherical wave-fronts diverging from this focus into plane wave-fronts, parallel to those entering the first lens; and, because these waves emerging from the second lens have plane fronts, they must, if they are allowed to enter the eye, come to a focus on the retina, and cause the eye to see a point of light, for precisely the same reason that it would see that point if the two lenses were removed, and the direct light from the vibrating molecule were allowed to enter it.

This is the principle of the refracting telescope; the first lens represents the object-glass, and the second lens the eye-piece.

The Diagram 6 represents the object-glass, the eye-piece, and the eye, in their proper relative positions; also the light-waves from an in-

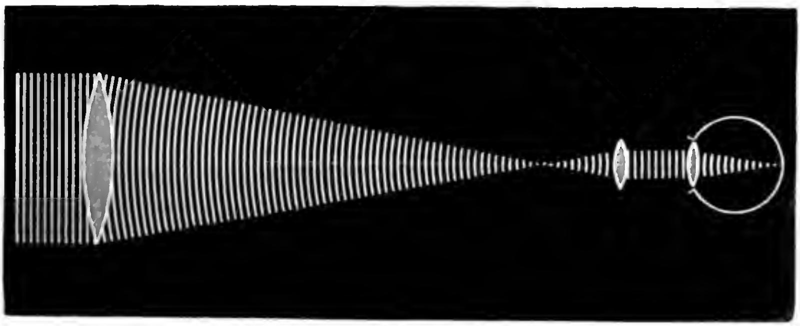

DIAGRAM 6.

finitely distant vibrating molecule entering the object-glass, emerging from it with spherical wave-fronts, which converge to a point of great agitation or focus, whence they diverge with spherical fronts, until, by passing through the eye-piece, they are converted into plane wave-fronts; thence, entering the eye, they come to a focus on the retina.

The diameter of the pupil of the eye being one fifth of an inch, the eye-piece must be of such a focal length that it can be placed so near the focus of the object-glass that the diameter of the emerging cylinder of plane wave-fronts shall not exceed one fifth of an inch, else the cylinder of light entering the object-glass will not be reduced in diameter by its passage through the object-glass and eye-piece to a cylinder of light small enough entirely to enter the eye.

When, however, this condition is fulfilled, it is clear that, when the eye receives the light from a luminous point through such a telescope, that point must appear as much brighter than it would if viewed directly, with the telescope out of the way, as the area of the object-glass exceeds the area of the pupil of the eye.

Bearing in mind the properties of similar triangles, it is also plain from Diagram 6 that the diameter of the cylinder of light-waves emerging from the eye-piece is as much less than the diameter of the cylinder of light-waves entering the object-glass as the focal length of the eye-piece is less than the focal length of the object-glass. As the focal lengths of object-glasses never vary much from thirteen times their diameter, the focal length of the eye-piece must be thirteen times the diameter of the emerging cylinder of light-waves, which, as just stated, should never exceed in diameter that of the pupil of the eye. Hence the focal length of the eye piece should never exceed thirteen times one fifth of an inch, or about two and a half inches. This is the greatest focal length which an eye-piece can have to utilize the whole aperture of such an object-glass; to use an eye-piece of greater focal length admits to the eye light only from the central part of the object-glass, and stars appear fainter through it than they do through an eye-piece whose focal length is equal to, or less than, two and a half inches.

As already stated, the vibrating molecule, the center of the lens, and the focus of the converging spherical wave-fronts emerging from it, lie in a straight line.

Diagram 7 represents, with center lines only, to avoid confusion,

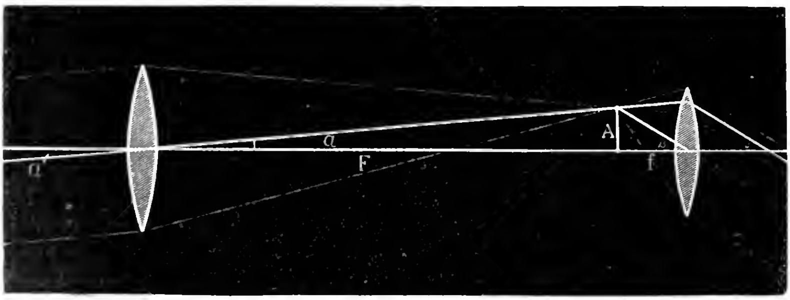

DIAGRAM 7.

the light from an infinitely distant vibrating molecule, situated at an angular distance a from the direction of the axis of the telescope, passing through the object-glass and eye-piece. On emerging from the eye-piece the light will be traveling in a direction whose inclination to the axis of the telescope is equal to the angle β.

The actual angular distance of the luminous point from the axis of the telescope is a, but it will appear to an eye looking into the eye-piece to lie at an angular distance β from the axis. The magnifying power of the telescope is therefore equal to the angle β divided by the angle a.

The distance A of the focus of the converging waves from the axis is very small, and will equal zero when the luminous point is on the axis, when F will equal the focal length of the object-glass and f of the eye-piece. Extremely small angles being proportional to their tangents, the diagram shows the following expression to be true:

$$\text{Magnifying power of telescope} = \frac{\beta}{a} = \frac{tan.\,\beta}{tan.\,a} = \frac{\frac{A}{f}}{\frac{A}{F}} = \frac{F}{f}, \quad \text{proving}$$

that the magnifying power of a telescope equals the focal length of its object-glass divided by the focal length of its eye-piece.

We have just seen, by similar triangles in Diagram 6, that the focal lengths of the object-glass and eye-piece are proportional to the diameters of the cylinders of plane wave-fronts entering the object-glass and emerging from the eye-piece; it follows, therefore, that the magnifying power of a telescope equals the diameter of the entering cylinder of light divided by the diameter of the emerging cylinder of light.

The easiest way to measure the magnifying power of a telescope is to divide the diameter of the clear aperture of the object-glass by the diameter of the little circle of light seen in the center of the eye-piece when the telescope is pointed at the bright sky, it being assumed that it is in focus for an infinitely distant object. This small circle of light seen in the center of the eye-piece is really an image of the object-glass formed by the eye-piece; but, when the light-waves emerge with plane fronts, the size of this image is exactly equal to the size of the emerging cylinder of plane wave-fronts, so that this method of finding the magnifying power is strictly accurate.

We have seen that, with an eye-piece not exceeding two and a half inches in focal length, luminous points appear through the telescope as many times brighter than they do to the naked eye as the area of the object-glass exceeds the area of the pupil of the eye; and it also follows directly from what has been already stated that, with this eye-piece, the apparent angular distance between two luminous points is proportional to the focal length of the object-glass used. A curious thing following from this is, that surfaces having sensible areas appear no brighter through large telescopes than they do to the naked eye; and it can be stated generally that, using a two-and-a-half-inch eye-piece, which gives the brightest image of an object with any sized object-glass, the surface will appear equally bright, whether seen by the naked eye or through a telescope of any size. The apparent dimensions of the surface, however, will increase directly with the dimensions of the object-glass. This explains why large and faintly luminous surfaces, like comets' tails and the aurora borealis, can be seen no better, if as well, through a telescope than by the naked eye.

We have seen why with any object-glass a lower power than that due to a two-and-a-half-inch eye-piece can not be used without loss of light, and a corresponding decrease in the apparent brightness of luminous points seen through it. We will next consider the reasons which prevent, with a given object-glass, an indefinite increase of magnifying power, and, in fact, confine it to within quite moderate limits. We have all seen beautiful engravings showing as well as it is possible the best views ever obtained of objects like Saturn, Mars, the surface of the Moon, and solar cyclones as they appear through some of the great telescopes, and it must naturally occur to many to ask why a still higher magnifying power than those used can not be employed to make such objects appear still larger and more distinct, for it is certainly easy enough to make eye-pieces of shorter focal length than those used in making the engravings just referred to, which, with a given object-glass, is the only thing upon which the magnifying power depends.

When the focal length of the eye-piece becomes reduced to one sixth of an inch, the diameter of the cylinder of light-waves entering the eye can only be about one thirteenth of this, or less than one seventy-fifth of an inch, as is obvious from Diagram 6, and the eye now becomes sensible of the same blurring effect that was found to occur in looking through the needle-hole; and, if a brilliant object too small to have visible dimensions is observed through the telescope with such an eye-piece, it will appear as a disk of considerable size surrounded by one or two bright rings.

These are the diffraction disk and rings, always seen in viewing a star through a good telescope with a high magnifying power. The disk is brightest at the center, diminishing somewhat in intensity toward the edges, for which reason the diffraction disks of faint stars appear slightly smaller than do those of bright stars.

Their appearance is not simply due to the smallness of the cylinder of light entering the eye through the eye-piece, but it must be remembered that it is the diffraction disk and rings at the focus of the object-glass which are viewed through the eye-piece, and not an absolute point of light. The effect of this, however, can not ordinarily be distinguished in the appearance of a star, so that in practice it is found that the apparent diameter of the diffraction disk of a star, expressed in seconds of arc, equals about four and a half divided by the number of inches in the diameter of the clear aperture of the object-glass.

The diffraction disk becomes very important in observing close double stars. It is obvious that, unless the two diffraction disks of the component stars can be clearly separated, the star can not be seen to be double; to accomplish which the distance between the centers of the stars must at least equal the diameter of the diffraction disks.

In other words, the closest double star which a telescope will separate, expressed in seconds of arc, equals four and a half divided by the diameter of the aperture of the object-glass in inches.

A 4½-inch object-glass will separate the components of a double star when they are within one second of each other; a 9-inch object-glass when within half a second of each other, and a 30-inch object-glass when within about one seventh of a second of each other.

Diagram 8 shows the advantage of increasing the aperture of the

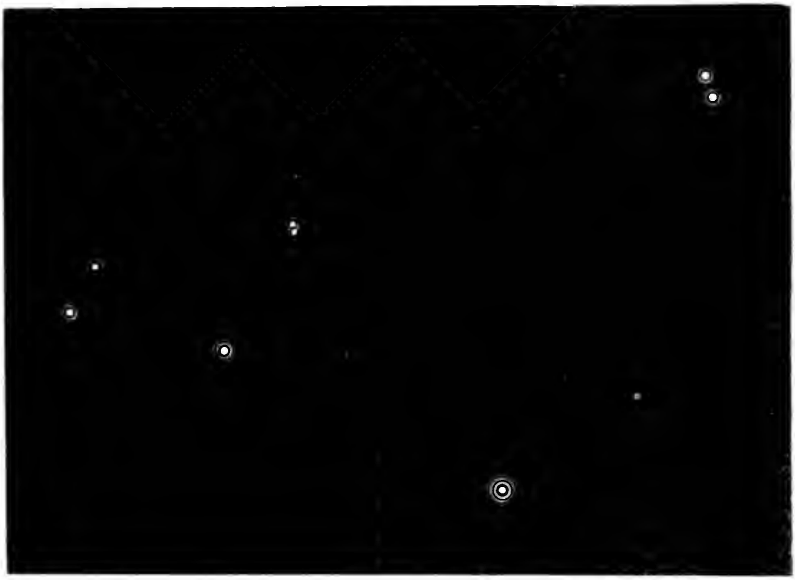

DIAGRAM 8.

object-glass; it represents the triple star γ Andromedæ as seen through a 4½-inch, 9-inch, and 30-inch object-glass, in all cases with a one-sixth-of-an-inch eye-piece, which makes the diffraction disks plainly visible, and in every case of the same apparent size but of a brilliancy proportionate to the area of the corresponding object-glass. Through the 4½-inch the upper star can not be separated into two, through the 9-inch, however, both components are distinctly visible, while through the 30-inch they appear widely separated.

If the one-sixth-of-an-inch eye-piece were replaced by another whose focal length was only one twelfth of an inch, the apparent distance between the centers of the stars would of course be twice as great, but the diameter of the diffraction disks would also be twice as large, and therefore have but one fourth their former brightness, and the close double star, instead of being seen to better advantage, would merely appear as two larger and much fainter disks than before, and could not be divided so well.

A very good way to see the effect of using a power high enough to make the diffraction disks obtrusively large is to point the telescope at a rough stone building in very strong sunlight. The small crystalline surfaces in the stone reflect the sun in little shining points of light, which, observed through the telescope, make the building appear as if stuck all over with silver dollars, while an unnatural glassy blurring of the whole image is very apparent. If the illumination will bear it, this appearance can be greatly exaggerated by covering the object-glass with a pasteboard diaphragm in such a manner as to considerably reduce its clear aperture.

For exactly the same reason, a similar blurred appearance is disagreeably noticeable when objects like the Moon or Jupiter are observed with an extremely high power.

From what has just been said, it is obvious that a power higher than that due to a one-sixth-of-an-inch eye-piece is of very little use in connection with an object-glass whose focal length is about thirteen times its clear aperture ; but, had the waves of light been created more minute than they are, it would have been possible to employ with advantage a still higher power.

It is thus seen that the focal lengths of telescopic eye-pieces, no matter what the size of the object-glass may be, should all lie between the very narrow limits of two and a half inches for the lowest power and one sixth of an inch for the highest power ; six or seven of them give a sufficient range of magnifying power to fully utilize the object-glass of any telescope.

A convenient way of expressing the limiting magnifying powers of a telescope in terms of the size of its object-glass, independently of its ratio of aperture to focal length, is easily deduced from the above by a simple proportion, and is as follows : a telescope will not bear with advantage a lower magnifying power than five nor a higher magnifying power than seventy-five for every inch of clear aperture of its object-glass.

In all that has gone before, we have confined ourselves to the consideration of the single set of light-waves originated by a single vibrating molecule, and to single-convex lenses, having surfaces of the proper curvature, to convert the convex spherical or plane wave-fronts into concave spherical wave-fronts ; but how is it in reality?

We have seen that the light of the sun originates in clouds of precipitated carbon from the great upward currents of metallic vapors rising from its interior. It can be demonstrated that the molecules of water are so small that, were one drop enlarged to the size of the earth, the individual molecule would only come up to the size of horse-chestnuts. There is no reason to think that carbon-molecules differ greatly from this in size. Therefore we receive from the sun the enormous number of light-waves originated by each vibrating molecule, suspended through a depth of many miles in the transparent vapors at the surface of a globe 885,000 miles in diameter. These light-waves reach us of every possible length between the limits already referred to, and vibrating in every possible plane, so that, even if our lens would make the wave-fronts emerge spherical, it would be found that the long red waves would come to a focus considerably farther out than would the short violet waves, and confusion of the image and colored fringes would result. It is also found impossible to construct lenses with surfaces of any other shape than spherical; consequently the optician has quite a complicated problem to solve before he can construct an object-glass which will not only make the wave-fronts emerge strictly spherical, but which will also make the red, green, and violet waves unite at the same focus, and thus cause all the waves from each luminous point like a star, which is a sun, like ours, too distant to have visible dimensions, to agitate but a single rod of the retina.

In practice, this is almost perfectly accomplished by combining a convex lens of crown-glass (the optical name for plate-glass) with a concave lens of flint-glass (the kind used for the finest cut-glass for table-ware), placed close together; but, to arrive at this result when the lenses are of large aperture, requires an amount of skill and patience attained by few.

Diagram 9 shows the two most approved forms of object-glasses.

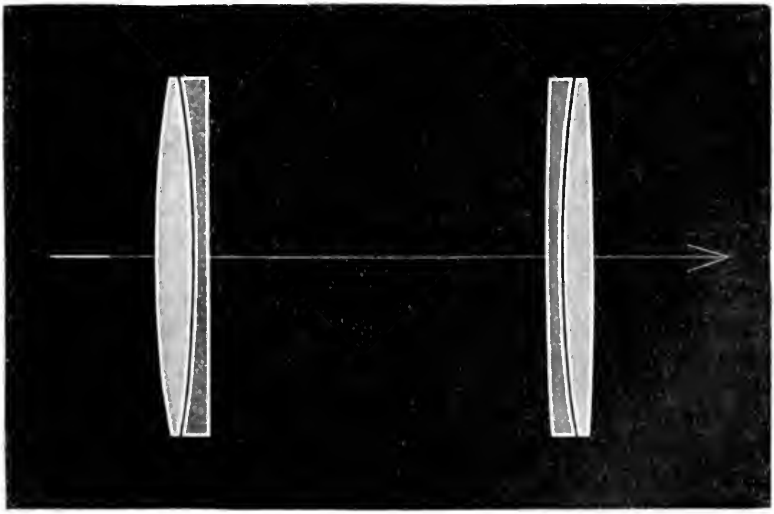

DIAGRAM 9.

The first is that used by Alvan Clark, in the largest and most perfect telescopes ever constructed. It consists of a double-convex lens of crown-glass, combined with a plano-concave lens of flint-glass, the crown-glass lens being placed in front. Both surfaces of the crown-glass lens and the first surface of the flint-glass lens have the same curvature. The focal length of this object-glass is nearly equal to four times the common radius of curvature of the three surfaces just mentioned.

The second is that derived by Dr. Charles S. Hastings from an elaborate mathematical investigation of every possible form of telescopic object-glass. In this form, on the contrary, the concave flint-glass lens is placed in front of the convex crown-glass lens, and close to it. The two inner surfaces have nearly the same curvature; the two outer surfaces, though not quite alike, have a curvature whose radius differs but little from three and a half times that of the inner surfaces. The focal length of this object-glass is about four times the radius of curvature of the inner surfaces. This form of object-glass gives the sharpest definition attainable with the use of only two kinds of glass whose surfaces are of reasonably small curvature.

THOMASVILLE AS A WINTER RESORT.

By E. L. YOUMANS.

AS the winter season approaches in the Northern States and in Canada, with its dangers to many and its discomforts to all, the question will be often asked, "Where shall we go to secure the best advantages of a milder climate?" The obvious, and with many the sufficient, answer will be, "Go South, where it is warmer." This may be satisfactory for the numerous and increasing class of well-to-do, leisurely, and healthy people who seek a change of climate purely as a matter of personal enjoyment. They are simply in quest of pleasurable sensation, and their instincts may be trusted to find the nicest places with luxurious accommodations, ample amusements, social gayety, and whatever can make the time pass pleasantly; and when they get tired of one place they can find another with fresh novelties and attractions. But, wherever they go, these people are extremely useful. They constitute the great mass of the patrons of Southern winter resorts. Their numbers each year are rapidly augmenting, and the money they spend contributes materially to promote those increasing facilities of travel, hotel-accommodations, and town-improvements of which all share the advantage.

But there are a good many others to whom the question, where to go to escape the inclemencies of a Northern winter, is less simple and more serious. These are invalids laboring chiefly under various forms of pulmonary trouble. When such are advised by the physician to seek a more congenial climate, the question where to go becomes urgent and often perplexing. Happy the patient advised to change his climate when the physician knows enough to give him intelligent instructions as to whither he shall proceed. Does he need a mild or a high temperature? a damp and relaxing, or a dry and bracing air? an inland location, or the sea-side? a valley or a mountain? Should he try Bermuda, or Aiken, or Nassau, or St. Augustine, or Asheville, or any of the score of resorts recommended for pulmonary invalids? If the doctor settles the point, it is well; if not, the patient must take his chances and do the best he can to settle it for himself.

I found myself last year among those who are embarrassed by this question. With lungs badly out of order, everybody said I must escape the severities of a New York winter by going somewhere. I advised with several eminent pulmonary experts, who agreed that it might be a good thing to get away, but did not seem to think it made much difference where I went. I therefore consulted the books on American winter sanitary resorts, in order, in connection with what I had heard, to decide what course to take. The climate of Southern California has its undoubted claims which are well appreciated, but it is far away. Colorado has its advantages, but is liable to sudden and extreme changes. San Antonio, in Southwestern Texas, is unquestionably an excellent place, with its pure, invigorating air, its mild temperature, and absence of extreme cold, although fierce and frigid "northers" are liable to swoop down upon it with but little warning, and it is also a long way off—two thousand miles by rail. Florida is popular and has many attractions, but it is chiefly low, and is generally damp and malarial. No place is without its drawbacks; but, in looking over their various claims with reference to my own condition, I concluded at last that Thomasville, Georgia, promised to be as eligible as any, and thither I went.

I found the place eminently satisfactory, and, although without experience of other and rival localities, I am sure that Thomasville has advantages as a Southern residence in winter and spring which must give it increasing and decided prominence as it becomes better known. Of course, the transition from "North" to "South" in February—from bleak, stormy, ice-bound winter to the soft and sunny atmosphere and vernal aspects of flowery spring—is full of delightful sensation wherever experienced; while the change of environment in passing from a Northern to a Southern community for the first time, intensifies the pleasurable effect. But, besides this, I was much gratified by the special attractiveness of the place, and the promise it offered as a healthy residence.

Thomasville, the capital of Thomas County, Georgia, is located two hundred miles from the Atlantic coast, fifty-five miles from the Gulf, within twelve miles of the Florida border, and on the Savannah, Florida, and Western Railroad. It stands upon a ridge or plateau covered by extensive pine forests, and at a height of about three hundred and fifty feet above tide-water. It is an old town, with upward of four thousand inhabitants, pleasantly laid out with wide streets, and containing many noble and stately trees—one superb oak being worth going every day to see. The air is pure, dry, and balmy, from the all-encompassing pine woods, through which radiate many walks and diversified drives in all directions. There are half a dozen different kinds of churches, and several considerable hotels. The "Piney Woods Hotel" and the "Mitchell House" are large, new, and first-class. The former has a frontage of over four hundred feet, is three stories high, and with broad piazzas front and rear. It will accommodate three hundred guests, has all the modern accommodations and improvements, except an elevator, and is so thoroughly well kept as to lead to the remark, which I heard frequently made, that the "Piney Woods is the best hotel South." There are lesser hotels and numerous boarding-houses, of the merits of which I know nothing, but heard them very well spoken of. The weather in Thomasville I found mild and agreeable. It rains there often, and sometimes hard, but the sandy ground quickly dries. The average winter temperature is given at 54·55° Fahr., but it is not to be inferred that they have no cold weather there. They have at times heavy frosts and ice, and report a fall of snow once in the last fifteen years. But the "cold spells" are short, and the prevailing warm and sunny weather invites to out-of-door life, which is the main thing, for, as Dr. Felix Oswald says, consumption is a "house disease."

I do not suppose there are any magical healing powers for pulmonary invalids in the Thomasville atmosphere, but I should hesitate to say that it may not be very favorable to them. An old physician of the place, Dr. T. S. Hopkins, after twenty years' medical experience in the pine forests of Southern Georgia, speaks as follows upon this point in the "Atlantic Medical Register": "Having for many years, in my travels through this section of country, noticed the almost entire absence of consumption among the people, I addressed letters to a large number of physicians practicing in the district, asking them to report to me the number of cases of consumption coming to their knowledge during the previous years. I received replies from twenty engaged in active practice, and representing a population of fifty thousand eight hundred and eighty-seven. The total number of cases reported was *three*. I have no reason to doubt the honesty of this report. A climate in which the disease so rarely occurs is certainly worthy of a trial by those who have it." As for myself, I can by no means report "cured" at Thomasville; but my case was undoubtedly improved there. And, as I might have died in New York, just according to the danger of this contingency, Thomasville must be entitled to the credit of saving my life. At any rate, the trial was a good thing, and I esteemed myself fortunate in the place selected.

In the matter of recreations, which is of considerable hygienic importance in a sanitary resort, Thomasville is quite undeveloped. There are several well-equipped livery establishments, and there is a good deal of horseback-riding and carriage-driving on the excellent thoroughfares of the town and the pleasant roads through the woods and the farming country. But, though the prices are reasonable, this amusement is only for those who can pay for it. There was no bowling-alley last year, though one was promised for the ensuing season. But what is most needed of all in such a place is a gymnasium, where active and regular exercise may be taken to counteract the besetting evils of idleness, and as an indispensable means of improving the health. Our constitutions are made for activity, and only those who cultivate their bodily powers by systematic exercises really know what enjoyment there is in well-earned appetite and invigorated life. The facilities for simple but adequate gymnastic exercises do not cost much, and, while the large majority of visitors would probably not patronize them, they would yet be invaluable to many. In the absence of a regular gymnasium, however, I fell back on Wood's five-dollar "Parlor Gymnastics," which can be carried in a satchel and used anywhere, and which really answers a most excellent purpose. They have a Library Association at Thomasville, and a very pleasant reading-room, but a larger stock of books is much needed.

There was, however, one never-failing source alike of interest, amusement, and instruction, which, though not confined to Thomasville, very much alleviated the monotony of my stay; I mean the "colored brother." As an abstraction from much reading I had long known him; but it was different to come upon the negroes in concrete mass, in their *habitat*, so as to observe the attributes of the actual object in a composite state of society. This was all new to me, and, with my old abolition education of strong convictions and little real knowledge, I found extreme interest in studying the negro direct, as a social object-lesson. He is playing his new part as citizen, voter, politician, laborer, learner, litigant, and Christian, with curious and instructive results; and in observing his treatment in the courts, in getting the views of individuals, in looking into the colored schools, but, most of all, in attending the so-called religious services in the colored churches, a good deal of time was pleasantly and usefully occupied, and I came to the conclusion that the more Northern people go South and see for themselves the more they will know of those facts which it is very important they should better understand.

THE SPIRIT AND METHOD OF SCIENTIFIC STUDY.*

By Professor J. P. LESLEY.

MY FRIENDS: I have the honor to address you this evening as an association of representatives of American science in all its branches—as students of the sky and all its elemental forces, of the earth and all its mineral constituents, of the animal and vegetable kingdoms in their past and present ages, of the history and constitution of the human race—and I may be easily pardoned for some trepidation in view of the drafts you may have drawn in advance on my slender exchequer. I have lain awake o' nights, like my predecessors, reflecting how I should meet my liabilities. And like them, no doubt, I find myself poorer than when, a year ago, I contracted them. You would scorn to receive in payment my promissory notes or mortgages on my castles in Spain. You will accept nothing but gold and silver, in bullion or in coin; and that is what troubles me.

There were once halcyon days for orators: the world of knowledge limited, and canopied with rosy clouds of curious speculation; the birds of fancy singing in every bush; the dew of novelty glittering on the fields. Science was then an early morning stroll with sympathetic friends, uncritical and inexpert, to whom suggestions were as good as gospel truths. Then, such a reunion as this to-night was a sort of picnic-party, at some picturesque place on the shore of the unknown, hilarious and convivial.

All that has passed away. The sun of science now rides high in heaven, and floods the earth with hot and dusty light. What was once play has turned to serious toil. Shadows are short. Objects present themselves in well-defined and separated shapes for critical examination. The few and early risers have become a multitude. The tumult of occupations distracts the studious observer. No one lends ear to chit-chat. All are hurried. Critics abound. "Say what you want, and go; or tell us something absolutely true and useful," is the introduction to every conversation. Morning, noon, and night, men demand, not the agreeable, but the necessary. The age of romance in science is part of the forgotten past. The new world has grown gray-haired in fifty years, intolerant of the irresponsibility, the sportiveness, the poetry, the music, the superstitions, the affections, of its youth; dealing only in hard facts, and in their causes and consequences; weighing and measuring all things; analyzing all things; collating, comparing, and classifying; insisting upon investigation at all points; formulating rigid laws; scoffing at the unseen and unknowa-

* Address to the American Association for the Advancement of Science at Ann Arbor, August 26, 1885, by the retiring President of the Association. Reprinted from "Science."

ble; and transmuting the fear of God and the hopes of heaven into a zeal for the exact determination of the units of force, and a confident expectation that railroads will soon traverse all the unoccupied regions of the earth, and malleable steel replace wood in the mechanic arts.

You represent this new world, grown so suddenly old, learned, utilitarian, and critical. Your orators have a hard time of it.

Am I to be the mouth-piece of the outside world, setting forth in order what it has expected of you—its praise, its blame? Nay, what care you for praise from uninspired lips? Or what care you for blame from the vulgar herd who comprehend neither your purposes nor your methods?

Am I to be your mouth-piece to inform this outside world of what the community of science which you partly represent has been about the last twelve months, giving it such a catalogue of facts discovered, and theories established or improved, that it shall stand amazed, and bless its stars and worship? Then this address would simply be a grandiloquent stage-aside in the drama of this meeting, and no address to you.

Must I, then, speak to you as a fellow-worker in science, contributing some fresh gifts to our common stock of truths? But that would be better done, if done at all, by reading a paper on the subject in the section to which I properly belong.

I did, indeed, hesitate a while before I rejected a temptation to discuss before you this evening one or two subjects on which I have reflected for many years—for instance, the important *rôle* which the chemical solution of the limestone formations has played in the grand drama of the topography of the globe; the absolute inconstancy of the ocean-level; the function of variable deposition in closed basins in elevating the plane at which coal-vegetation repeated itself; the influence which anticlinals and synclinals *en échelon* have exercised in originally directing, and afterward perpetually shifting, the systems of river-drainage, as the general surface became lower and lower through erosion; the extraordinary differences in the amount and rate of erosion in different parts of the same region, due to the various heights and shapes of the plications—but a deep sense of insufficiency for properly handling such great subjects deterred me from the attempt. They demand the largest treatment, the fullest illustration, and the long co-operation of many minds. All the great transcendental questions of science remain open to research; not one of them has as yet been answered satisfactorily; all answers have been premature, and most of what has been published for such seems to me puerile; yet the disposition to deal in transcendental science seems to grow daily stronger. There are no laws, however, against initiation into Alpine clubs. If men choose to run fatal risks for notoriety, let them do so, in the name of all that is chilly and unprofitable; but let them not pretend that, when they reach the summit of some Jungfrau or

Matterhorn, their demon of adventure shows them all the kingdoms of the world of science, and the glory of it; for in fact, the inaccessible sky surrounds them still, and clouds obstruct their vision in every direction. I have no fancy for such mountain-climbing, and think lightly of exploits so barren of results.

I seize the occasion, rather, to awake to your remembrance some thoughts of common interest, which the multiplying avalanches of facts and theories threaten to bury out of sight, as the pure ice of the glacier gets covered over with a sordid sheet of *débris*, perpetually tumbling from the cliffs between which it flows.

Consider, then, first, that the final cause of a glacier is not to carry moraines, lateral or medial; that these are mere accidents of its existence; and that, were it endowed with intelligence, it would feel little interest and less pride in the heterogeneous, variable, and for the most part useless, burden, which it can not escape, and throws away at the close of its career. Such are the loads of science which we are compelled to carry forward through life, in the forms of fact and theory; misshapen, accidental droppings upon us from our local surroundings; fragmentary specimens of knowledge, of which we construct our confused and shapeless heaps of learning, most of which is of little use, either to ourselves or to the world. The life of the glacier is an elaboration of the universal moisture into snow, *nevé*, and pure ice, by a slow process of internal constitution; and such is the happy destiny of the true man of science, worked out in wisdom of character, apart from all accidental accumulations of learning, and mainly irrespective of them.

Let us avoid the sacrifice of character to science. As the saying of Jesus of Nazareth, that the sabbath was made for man, not man for the sabbath, has rung through the centuries, a tocsin of alarm to rouse mankind to resist ecclesiasticism, so let the warning cry fill the air of our association, from meeting to meeting, that science is our means, and not our end. Self-culture is the only real and noble aim of life. And as the magnificence, beauty, and utility of a glacier, as a perpetual reservoir of solid moisture, are not gauged by the size, arrangement, or constitutional features of its moraines, neither are the greatness and usefulness of the philosopher measured by his amount of the knowledge of the physical fact-and-theory science of the times.

Of all kinds of intellectual greatness, the greatest is achieved by the philosopher who stands before the thinking world as a model of scientific virtue; deaf to flattery; insensible to paltry, hostile criticism; patient of opposition; dead to the temptations of self-interest; calmly superior to the misjudgments of the short-sighted; whom nothing diverts from the endeavor to live nobly, and to whom noble means are as indispensable as noble ends; in whom the most brilliant successes foster neither vanity nor arrogance; to whom fame is unimportant, and poverty a trivial circumstance; whose joys, like fragrant breezes from an encircling landscape, come from the surrounding friendship of the general world, to whose best interests the noble heart is forever loyal.

Another subject for serious reflection is the over-accumulation of scientific information. To broach it before such an assembly may seem to require some apology. Certainly the feeling prevails that the world can not have too much science. But the science of learning and the science of knowledge are not quite identical; and learning has too often, in the case of individuals, overwhelmed and smothered to death knowledge. The average human mind, when overstocked with information, acts like a general put in command of an army too large for him to handle. Many a vaulting scientific ambition has been thus disgraced. Nor is this the only danger that we run; for the accumulation of facts in the treasury of the human brain has a natural tendency to breed an intellectual avarice, a passion for the piling-up of masses of facts, old and new, regardless of their uses. In the great game of our spiritual existence, facts are mere counters with which to play the game. A million of them are worth nothing, unless the player knows how to play well the game; and, when the game is over, the worthless counters are swept back into the drawer. And the danger pursues us to higher and higher planes of science. Not only the avarice of facts, but of their explanations also, may end in a wealthy poverty of intellect, for which there is no cure. Even the sacred fires of research may be allowed to burn too long, until, in fact, they turn the investigator into a mere miser of ideas. As for those who are not themselves original investigators, but busy themselves incessantly in appropriating the secretions of research at second hand, how often it happens that the richest additions of reliable theories to the stock of their ideas, even to a point where they suppose themselves, and are supposed by others, to know all the conclusions arrived at by past and present inquirers, leave them as thinkers just what they were at first—incompetents; mere ill-hung picture-galleries; disarranged museums; complicated inventions which will not work; costly expeditions for discovery, frozen fast and abandoned in the polar ice!

A certain temperance in science is obligatory from another point of view. As mere wealth of possessions can not guarantee happiness, neither can a superfluity of learning insure wisdom. When the body from overfeeding grows plethoric, its vital energies subside and its life is endangered. The intellect may be mischievously crammed with science. How much we know is not the best question, but how we got what we know, and what we can do with it; and, above all, what it has made of us. The tendency of training now is to subordinate the soul to that which should be merely its endowment and adornment; to turn the thinker into a mere walking encyclopædia, text-book, or circle of the mechanic arts; not to produce the highest type of man. What ridiculous and pitiable creations are these!—an authority in physics who can not speak the truth? a leader in natural history who is given over to the torments of envy? a god in chemical research sick of some false quotation? a youthful prodigy of mathematical science tottering with unelastic steps and outstretched arms to grasp his future fame? Yet no one will deny that the intemperate pursuit of any branch of science has a tendency to produce such characters, by elevating to undue importance the individual accumulation of scientific facts and scientific theories, to the neglect and depreciation of that spirit of truth which alone can inspire and justify an earnest study of the material universe. I beg you to reflect that it is as true of science as of religion, that the mere letter of its code threatens its devotee with intellectual death, and that only by breathing its purest spirit can the man of science keep his better character alive—that indefinable spirit which, in its intimate and essential nature, has little to do with the number of facts discovered or theories accepted; a spirit which merely exercises itself in research, and accepts discoveries as delightful accidents; a spirit which walks the paths of science, not as if they were turnpikes converging upon some smoky and squalid focus of toil-wearied population, but as if they had been graveled and flower-bordered for it through some princely park; a spirit of natural and cultivated nobleness, sweetened by boundless friendship for the world and all that lives therein; just and true to all men worthy or unworthy, proud without vanity, industrious without haste, stating its own griefs as lightly as an angel might, and generously bringing help to the discouraged and forlorn. In every one of us there is this genius, if we did but know it; and, as Emerson well says, the moral is the measure of its health.

I have been saying, then, that we should pursue science, like any other business of this life, with a distinct and unwavering intention to ennoble our own characters. It were a trite addition to propose that the pursuit be made ancillary to the public good. "The love of science" is a phrase which has been greatly glorified in popular discourse; and if the phrase be confined to its true meaning—a zealous admiration for all that is beautifully true and useful in Nature—it can not harm us in the practice of our profession. But when the imagination has exhausted itself in transcendental ecstasies over an ethereal sentiment so named, but undescribed except in poetry, what wiser or better thing can we say of any branch of physical or natural science, cultivated by our association, than that its votaries are knowingly or unknowingly bettering the condition and character of mankind? Every advancement in science is, of its own nature, an improvement of the commonwealth. Every successful study of the laws of the world we inhabit inevitably brings about a more intelligent and victorious conflict with the material evils of life, encouraging thoughtfulness, discouraging superstition, exposing the folly of vice, and putting the multitudes of human society on a fairer and friendlier footing with one another.

The arts of philanthropy are, therefore, as direct an outcome of science as the lighting of the public streets or the warming of our homes. Cruelty and shame are products of the night. The daylight is a friend to friendliness. The progress of civilization and the progress of science are alike typified by the progressively brilliant and general illumination of cities. So, in old times, human sacrifices and piracy ceased wherever the worship of the Tyrian Melcarth yielded place to the philosophy, *belles-lettres*, and fine arts of the genial and beautiful Delphic Apollo, the civilizer, the far-shiner, the sun of Grecian righteousness, whose initiated became the educators of the modern world.

And yet these two magic words, "initiation," "education," have meanings directly the reverse of one another—the one a *going in* to learn the secrets of esoteric doctrine, unsafe for publication because immature ; the other a *being led out* from ignorance to knowledge, from helplessness to the active performances of life. The idea of universal education is wholly modern—in fact, a product of the century in which we live. It is democracy in the world of intellect ; it is the doctrine of equal human rights applied to the possessions of the human brain ; it is the apotheosis of common sense ; it demands the distribution of knowledge in adequate quantity and quality to all who live and all who are to live upon the earth. How this is to be accomplished is the greatest of the questions of the day, and it especially concerns us as members of an association for the advancement of science.

I do not intend to discuss the subject, to define the quantity and quality of knowledge adequate for the various classes of human society, or to propose any plans for its distribution. All I wish to say about it is, that it seems to me Nature limits both the responsibilities of teachers and the rights of learners more narrowly than is commonly supposed. The parable of the sower is a good reference for explanation. Most of the surface of the globe is good for little else than cattle-ranches or sheep-farms, and the large majority of mankind must in all ages be satisfied with the mere rudiments of learning. What they want is unscholastic wisdom with which to fight the fight of life, and they must win it for themselves. Only a limited number of persons in any community can acquire wealth of knowledge, and the only thought on which I wish to insist is this : these few must also get it for themselves, and, moreover, must work hard for it.

It is a hackneyed aphorism that there is no royal road to knowledge, although an incredible amount of pains has been taken to make one. Nature in this affair, as usual, has been a good, wise mother to us all ; for it is not desirable to make the acquisition of knowledge easy, for the main point in scientific education is to secure the highest activity of the human mind in the pursuit of truth—an activity tried and disciplined by hardship and nourished on hardy fare. The quantity of food is of less importance ; everything depends on establishing a good constitutional digestion. The harder the dinner is to chew, the stronger grows the eater. Canned science as a steady diet is as unwholesome for the growing mind as canned fruits and vegetables for the growing body. The wise teacher imitates the method of Nature, who has but one answer for all questions: "Find it out for yourself, and you will then know it better than if I were to tell you beforehand."

But who can be a wise teacher who has not been wisely taught? The spirit of this scientific age favors a universal manufacture of condensed milk to ease and cheapen the toil of bringing up its infants. It finds the bottle of literature more convenient than the breast of Nature. It prefers a large family of puny children to a few young heroes. The stalwart ancients exposed their unfit offspring to the wolves; we moderns exhaust the resources of art to preserve their worthless and painful lives.

This is the spirit which invents a thousand futile plans for compacting the universe to a size so small, and a shape so simple, that it can be grasped without much effort by the tiniest and feeblest hands. Will it be an unpardonable crime for me to say that I recognize the same spirit in the present popular rage for an over-classification, unification, and simplification of science; for ultra-symmetrical formulæ and excessive uniformity in nomenclature; with an avowed reference to ease of learning and convenience of teaching, the saving of time in the acquisition of facts, and the diminution of brain-waste in collating them for use; in one word, to the making of science easy, despite the inexorable decree of Nature, that it always shall be and always ought to be difficult? For the genius of the creation is visibly hostile to that uniformity, symmetry, and orderly simplicity which the text-book endeavors to establish. No logical consistency for her! No stiffening of the fact-producing energies into fact formularies will she endure. Hardly has a manual issued from the press, but it is mutilated by her Puckish fingers. No sooner has some school of theorists erected a stately structure in simple grandeur, than it is shattered by the lightning of a new revelation. There is no rest, no peace, in our believing. Our libraries contain little else than such spoiled palimpsests. The broad fields of science are covered with such ruins; and those who have grown old in traveling far and wide across them would find little cause for singing pæans to the exploits of science were it not for the fact that the function of science is not to organize Nature, but by the laborious study of Nature to organize the human mind and inform it with the very genius of Nature, original, unsymmetrical, indefinable, unclassifiable, changing its attitudes and operations every instant, and escaping easily from all the toils of scholastic unification which we spread for it. The work of the student can not be simplified, can not be made easy, if it is not to fail in its great purpose, the production of a genuine man of science. The foolish nurse thinks it her duty to carry the child always in her arms; but the test of a good education is the ability of the child to carry its nurse, and this it can only attain to through the discipline of toil—toil which at first conceals itself under the gracious guise of sports, gymnastics, and adventures, and afterward takes the shape of experimental failures and useless constructions, but all as free, untutored, and original as the laughing, wasteful, and ungovernable pranks of Nature. But I have followed long enough, perhaps you will think too long, this train of thought. Let me suggest another.

It is a familiar fact that great discoveries come at long intervals, brought by specially commissioned and highly endowed messengers, while a perpetual procession of humbler servants of Nature arrive with gifts of lesser moment, but equally genuine, curious, and interesting novelties. The excitement of the pageant incapacitates us for reasoning rightly on its meaning. From what unknown land does all this wealth of information come? Who are these bearers of it? and who intrusted each with his particular burden, which he carries aloft as if it deserved exclusive admiration? Why do those who bring the best things walk so seriously and modestly along, as if they were in the performance of a sacred duty for which they scarcely esteem themselves worthy; while those who have little to show, or things of inferior or doubtful value, strut and grimace magnificently, as if they felt themselves the especial favorites of Nature, push to the front, speak loudly to the multitude, and evidently deem themselves entitled to uncommon honors?

In this procession of science, in this interminable show of discovery, two facts arrest attention: first, the eager gaze of expectation which the crowd of lookers-on direct toward the quarter from which the procession comes, and their unaccountable indifference to what has already passed; and, secondly, the wonderful disappearance, the more or less sudden vanishing out of the very hands of the carriers, of a large majority of the facts and theories of which they make so pompous an exposure; few of them, however, seeming to be aware that thereby they have lost their right to participate in the pageant, and should retire from it into the throng of spectators, at least until good fortune should take pity on them, and drop some new trifle at their feet to soothe their wounded vanity.

You will not suspect me of depreciating the value of any real discovery, be it merely the finding of a Californian bird on the shore of Massachusetts Bay, or detecting with the naked eye the blazing of a variable star before any telescope had noticed it, or finding some Hadrosaurus bones in a New Jersey marl-pit, or a Paradoxides at the Quincy quarries? Such accidents have all the importance of trumpet-notes sounding to boots and saddle. But, after all, the trumpeter is only a trumpeter, although he may imagine himself the colonel of the regiment or a general in the army; and, indeed, it has happened that to such accidents Science has owed some of her best physicists and naturalists. But it was not these, their first and therefore most enjoyable discoveries, that made them what they afterward became, nor had they at the outset even the right to an opinion on the value of their finds. Years of strenuous and unrenowned exertion had to follow, in which they published little or nothing new, but gathered up the old, and rediscovered, by experiment and observation, what the records of the past preserved.

What I deprecate is the claim to special attention made by inexperienced stumblers on forgotten or unnoticed facts, remarkable or otherwise, on the sole ground of the discovery. I deprecate the folly of the youth who, because he has found a spear, leaps into the empty chariot of Achilles, and, calling on the Grecian host to follow him, lashes the horses for an immediate attack on Troy; nor finds it out until he is half-way across the plain, that he rides alone, and to destruction. I feel no admiration, no respect, for the audacity with which our young recruits of science rush unpanoplied into the thick of a discussion involving the greatest thinking of the age. They act like animals at a conflagration. I hear on all sides a noisy tumult of untrained intellects. Shall such themes as the nebular hypothesis, the probable solidity or fluidity of our planet, the metamorphosis of rocks, the origin of serpentine or petroleum, the cause of foliation, the stable or unstable geographical relationships of continent to ocean, the probable rate of geological time, the conditions of climate in the ages of maximum ice, the probable centers of life-dispersion, the unity or multiplicity of the human race, the evolution of species, be babbled over by men, the amount of whose efficient work in any branch of science is measurable with a foot-rule; while those whose entire lives have been but one exhausting struggle with the shapes which people the darkness of science speak with bated breath and downcast eyes of these great mysteries?

There is a shibboleth by which tyros in science can always be detected—their habitual employment of the words "doubtless," "certainly," and "demonstrated." To their inexperience of the universality of error, every new statement in print over a name noted in science reads like a revelation of the absolute; and every conclusion at which they themselves arrive, after a more or less superficial study of the limited number of facts which accident has given them the opportunity to observe, seems a conclusion too real to be impugned. I love the remembrance of my youth, but I regret its dogmatic impertinences. Young votaries of science draw their inspiration from the maxim which best suits them—"Try the value of old truths by new discoveries." The veterans of science reverse the rule, and test all new discoveries by a world of half-forgotten facts and well-established principles. The advancement of science is accomplished by the push and pull of these two ruling motives. No science were possible if the aged could suppress the youthful, or the youthful could extirpate the aged. But as surely as the agnosticism of age is a witness to the weariness of fruitless speculation, so surely the confidence of youth that every movement must of necessity be forward is a proof of insufficiency.

Let the military art instruct us. The raw recruit is satisfied if old Blücher waves his sword, shouting, "Vorwärts!" But the sobered veteran is prepared to see in flank-movements, in retreats, in halts and intrenchments, steps of the campaign as necessary as any charge at double-quick on hostile lines, or a steady march in column into the enemy's country. Let us suppose that in the last twelvemonth not one surprising discovery in any region of the globe has been made; that a hundred previously reported facts have been examined and pronounced untrue; a hundred printed memoirs, widely read and criticised, been proved mistaken or absurd; a hundred long-accepted generic or specific names, fossil or recent, have been expunged from the lists; and that others, like *Halysites catenulata* or *Spirifer disjuncta*, have lost their characteristic values; suppose any amount of doubt to have been thrown upon any number of popularly accepted theories, by failures in applying them to practice, like the theory of the anticlinal location of gas-wells; in a word, suppose any amount of smashing in any department of the great crockery-shop of transcendental or applied science—what does it imply but the tendency of all inquiry, observation, investigation, and experiment toward the betterment, which is the only true advancement, of science? As, in the animal kingdom, the peaceful kinds are offset and held in check by analogous carnivores, for fear of over-population, so, in the world of thought, the constructive theorists are perpetually preyed upon by a corresponding class of natural enemies, the destructive critics, which keeps the field open and the air sweet. The destruction of effete knowledge is the perennial birth of that science which can not be destroyed. But, in recognizing the fact, we should remember that there is a science of items and a science of fundamentals, which bear a relation to each other, like that which subsists between the individuals of a species and species *per se*; and that an indefinite multiplication of individuals may go on without any visible modification of their specific character. The population of Europe has grown in the last century from a hundred and fifty to three hundred and twenty millions of souls; but they are the same Teutons, Celts, and Slavs as ever. On the other hand, the curve of population for France is almost a horizontal straight line; but their national advancement has been phenomenal. What I wish to illustrate is this evident truth, that not by the mere increment of number of facts learned, not by the mere multiplication of discoverers, teachers, and students of those facts, but by the elevation of our aims, by the enlargement of our views, by the refinement of our methods, by the ennoblement of our personalities, and by these alone, can we rightly discover whether or not our association is fulfilling its destiny by advancing science in America. If, unhappily, our meetings should rather tend to cultivate a love for *bric-à-brac* in science, if the stimulation and gratification of a *quasi*-animal curiosity for scientific novelties be fostered, if our discussions should become hot-beds of a more vigorous vegetation of personal vanity, intellectual pugnacity, lust for notoriety, literary jealousies, conceited reclamations, petty ambitions, or pecuniary schemes, how are our day and generation to be benefited or improved? If our attention become restricted to the details of the creation, and to the smaller manœuvres of the forces of Nature; or if, on the other hand, we become habituated in the indulgence of vague generalizations, suggestions of possible theories, and half-completed or merely sketched and outlined hypotheses—how are we ourselves, as workers of science, to escape deterioration?

I can not shake off a suspicion that we talk and write too much; that the whole world talks too much; and that the golden time for silence is precisely then when we come together to talk. Were each of us to utter only what he absolutely knows, what he is quite sure of, what he has unimpeachable facts in sufficient number to confirm—what a sudden illumination would overspread our meetings, glorifying our science, and reinspiring us all! But I turn from the Utopian fancy, and invite your attention to a very different theme.

There is a topic which I think should be frequently considered by all who engage in scientific pursuits; and by none so earnestly as by those who are ambitious to reach the higher points of view, from which to survey and describe those systematic combinations of phenomena which are more or less panoramic: I allude of course to generalizers or discoverers of natural laws, and the professional teachers of such laws; while those who deal in itemized science, the mere observers of isolated facts, discriminating specimens and naming genera and species in the animal, vegetable, or mineral worlds, and especially such as occupy themselves with geographical and geological studies in detail, stand in less need of having it pressed upon their attention, because in their case it insists upon its own necessity.

I allude to what is technically known among experts as "dead-work."

This topic has to be treated in the most prosaic style. To describe dead-work is to narrate all those portions of our work which consume the most time, give the most trouble, require the greatest patience and endurance, and seem to produce the most insignificant results. It comprises the collection, collation, comparison, and adjustment, the elimination, correction, and re-selection, the calculation and representation—in a word, the entire first, second, and third handling of our data in any branch of human learning—wholly perfunctory, preparatory, and mechanical, wholly tentative, experimental, and defensive—without which it is dangerous to proceed a single stage into reasoning on the unknown, and futile to imagine that we can advance in science ourselves, or assist in its advancement in the world. It is that tedious, costly, and fatiguing process of laying a good foundation which no eye is ever to see, for a house to be built thereon for safety and enjoyment, for public uses or for monumental beauty. It is the labor of a week to be paid for on Saturday night. It is the slow recruiting, arming, drilling, victualing, and transporting of an entire army to secure victory in one short battle. It is the burden of dead-weight which every great discoverer has had to carry for years and years, unknown to the world at large, before the world was electrified by his appearance as its genius. Let us examine it more closely: it will repay our scrutiny. Those of you who have been more or less successfully at work all your lives may get some satisfaction from the retrospect, and those who have commenced careers should hear what dead-work means, what its uses are, how indispensable it is, how honorable it is, and what stores of health and strength and happiness it reserves for them.

My propositions, then, are these: 1. That, without a large amount of this dead-work, there can be no discovery of what is rightly called a scientific truth. 2. That, without a large amount of dead-work on the part of a teacher of science, he will fail in his efforts to impart true science to his scholars. 3. That, without a large amount of dead-work, no professional expert can properly serve, much less inform and command, his clients or employers. 4. That nothing but an habitual performance of dead-work can keep the scientific judgment in a safe and sound condition to meet emergencies, or prevent it from falling more or less rapidly into decrepitude; and, 5. That in the case of highly organized thinkers, disposed or obliged to exercise habitually the creative powers of the imagination, or to exhaust the will-power in frequently recurring decisions of difficult and doubtful questions, dead-work and plenty of it is their only salvation; nay, the most delicious and refreshing recreation; a panacea for disgust, discouragement, and care; an elixir vitæ; a fountain of perpetual youth.

In expanding these propositions, I would illustrate them in some such homely ways as should make them seem near and familiar principles of conduct; and of course I can only do this out of the experience of my own life, and from observation of what has happened in the limited sphere of one department of scientific inquiry; but that should suffice, seeing that work is work, and science science, however various may be minds and their pursuits.

First, then, is it so that scientific truths can not be discovered without a large amount of preliminary dead-work? Surely no one in this assembly doubts it who has established even one original theory for himself, or won for it the suffrages of judges capable of weighing evidence. Now, the immense disproportion in numbers between theories broached and theories accepted is the best proof we could have, not only of the value and necessity of dead-work, but of the scarcity of those who depend upon it as a preparatory stage of theorizing. And, moreover, not theories only, but simple statements of fact believed and disbelieved, that is, finally accepted or finally rejected, exhibit the like numerical disproportion, and betray a general carelessness or laziness of observers; at all events, their manifest lack of appreciation of the value and necessity of the dead-work part of observation, which imperatively must precede any clear mental perception of the simplest phenomenon, before the attempt is made to establish its natural relationships, and present it for acceptance as a part of science.

A geologist travels far to collect fossils at a particularly good locality, stops there a day or two, fills his valise, and returns to publish a paper on it. What is his paper worth? Were he first to spend a week in making himself acquainted with the whole vicinity, a second week in making measured sections of all the cognate outcrops in the neighborhood, a third week in carefully differentiating the specific horizons, and a fourth week in verifying their reliability, and in correcting his first mistakes, then, surely, whatever labor he should afterward expend upon his collection of life-forms would have its full value, and any paper he might write would be an important contribution to his branch of science.

I have known men settle to their own satisfaction some of the greatest problems in geology by a flying reconnaissance; triumphantly overturning a mass of accumulated science slowly brought to demonstration by many years of conscientious dead-work, which they did not seem to think it worth their while to verify. I have known men reclassify the elements of a geological system by a few sections, not a single one of which was properly measured by them, or could be properly put on paper in a graphic form for precise comparison. I have known men make what they called a geological map, without having run a single instrumental line themselves; with every outcrop inaccurately placed; with only here and there an accidental note of strike and dip, and even this not oriented with a close approximation to precision; covering a region requiring the study of many months with a few weeks of what they fondly called field-work, and basing on such a map generalizations of the first rank, for which they expected the world of science to give them credit—which in the long run it certainly will, but not the kind of credit they anticipate.

Now, the experience of a long and active life of science has trained me to regard all such work as careless work, lazy work. Not that such workers are lazy men in the common meaning of the word; on the contrary, they are busy, bustling, active, energetic, indefatigable men; in fact, too much so. In science there is a laziness of quite another definition—namely, a chronic dislike, a deep-seated disability, for the dead-work which first disciplines to accuracy, then makes patient and cautious, and finally bestows the clearest intelligence and largest comprehension of phenomena. And this fatal laziness is fostered by a strange misunderstanding, a fancy, sometimes a downright conviction, that the dead-work of science can be done for us by some one else, so as to save our time and strength for speculation, for thought, for fine writing—can be done by menials, employés, assistants, colleagues, special experts, by any one rather than by ourselves. Can we not, in fact, often find it already done for us, and even better done than we could do it? Then, why not let inferior minds occupy themselves with this laborious and time-consuming address of special skill? Can we not, for instance, hire transit-men to lay out and measure our sections, and artists to draw them? Why should a paleontologist take the pencil between his own fingers in studying species, when he has trained photographers and lithographers at his command? Why waste precious weeks and months in tramping and climbing, in measuring and plotting, while glory calls us and the scientific world is impatiently waiting for our conclusions? Thus possessed by the demon of scientific haste, we continually spoil our own performances and disappoint the expectant but not at all impatient world. Could our vanity permit us to know the fact, the impatience is entirely our own, and, if indulged, is sure to be roundly punished.

No, dead-work can not be delegated. The man who can not himself survey and map his field, measure and draw his sections properly, and perfectly represent with his own pencil the characteristic variations of his fossil forms, has no just right to call himself an expert geologist. These are the badges of initiation, and the only guarantees which one can offer to the world of science that one is a competent observer and a trustworthy generalizer. Nor has one become a true man of science until he has already done a vast amount of this dead-work; nor does one continue in his prime, as a man of science, after he has ceased to bring to this test of his own ability to see, to judge, and to theorize the working and thinking of other men. But enough of this.

My second proposition was, that no teacher of science can be successful who does not himself encounter some of the dead-work of the explorer and discoverer; who does not discipline his own faculties of perception, reflection, and generalization by field-work and office-work, independently of all text-book assistance; who does not himself make at least some of the diagrams, tables, and pictures for his class-room, in as original a spirit, and with as much precision of detail, as if none such had ever been made before, and these were to remain sole monuments of the genius of investigation. What the true teacher has to do first and foremost is to wake up in youthful minds this spirit of investigation *ab initio*. The crusade against scholastic cramming promises to be successful; but the crusade against pedagogic cramming has hardly yet been organized. How is the scholar to be made an artist if the teacher can not draw? The instinct of imitation in man is irresistible. Slovenly drawing on the blackboard—sufficient evidence of the teacher's imperfect information and inaccurate conception of facts, the nature of which he only thinks he understands—can do little more than raise a cold fog of suspicion in the class-room, by which the tender sprouts of learning must be either dwarfed or killed. But even slovenly diagrams are preferable to purchased ones, for whatever diminishes the dead-work of a teacher enervates his investigating and thereby his demonstrating powers, and lowers him toward the level of his scholars.

Were I a dictator, I should drive all teachers of science out into the great field of dead-work, force them to go through all the gymnastics of original research and its description, and not permit them to return to their libraries until their note-books were full of their own measurements and calculations, sketch-maps and form-drawings, severely accurate and logically classified, to be then compared with those recorded in the books. What teachers fail to keep in mind is this: that learning is not knowledge; but, as Lessing says: "Learning is only our knowledge of the experience of others; knowledge is our own." No man really comprehends what he himself has not created. Therefore we know nothing of the universe until we take it to pieces for inspection and rebuild it for our understanding. Nor can one man do this for another—each must do it for himself—and all that one can do to help another is to show him how he himself has morsellated and recomposed his small particular share of concrete nature, and inspire him with those vague but hopeful suggestions of ideas which we call learning, but which are not science.

My third proposition was, that an expert in practical science can command the respect and confidence of his professional fellows, and, through their free suffrages, build up his own reputation in the learned and business worlds, only in exact proportion to the amount of good dead-work to which he voluntarily subjects himself. For, although the most of it is necessarily done in secrecy and silence, enough of it leaks out to testify to his honest and diligent self-cultivation, and enough of it must show in the shape of scientific wisdom to make self-evident the fact that he is neither a tyro nor a charlatan. More than once I have heard the merry jest of the Australasian judge quoted with sinister application to experts in science. When a young colleague, just arrived from England, asked him for advice, he answered, "Pronounce your decisions, but beware of stating your reasons for them." Many an ephemeral reputation for science has been begot by this shrewd policy; but the best policy to wear well is honesty, and honesty in trade means selling what is genuine, well made, and durable, and honesty in science means, first, facts well proved, and then, conclusions slowly and painfully deduced from facts well proved, in sufficient number and order of arrangement to exhaust alike the subject and the observer. Reap your field so thoroughly that gleaners must despair. Fortify your position, that your most experienced rival can find no point of attack. Lay your plans with such a superfluity of patient carefulness that Fate itself can invent no serious emergency. Demonstrate your theory so utterly and evidently that it shall require no defender but itself. Die for your work, that your work may live forever. Forget yourself, and your work will make you famous. Enslave yourself to it, and it will plant your feet upon the necks of kings, and your mere Yes or No will become a law to multitudes. This is what the dead-work of science, when well done, does for the expert in science.

My fourth proposition—that only the habitual performance of dead-work can preserve the scientific intellect in pristine vigor, and prevent it from becoming stiffened with prejudices, inapt to receive fresh truth, and forgetful of knowledge already won—hardly needs discussion. Human muscles become atrophied by disuse. Men's fortunes shrink and evaporate by mere investment. I pray you to imagine what I wish to say, for it all amounts to this—that the grass will surely grow over a deserted foot-path. Let me hurry to the close of this address, which I have found too serious a duty for my liking, and perhaps you also have found it too personal a preachment for yours. One more suggestion, then, and I have done.

My fifth proposition was, that the wearied and exhausted intellect will wisely seek refreshment in dead-work.

The physiology of the brain is now sufficiently well understood to permit physicians to prescribe with some assurance for its many ills, and to regulate its restoration to a normal state of health. Its tissues reproduce themselves throughout life if no extraordinary overbalance of decay takes place, if there be no excessive and too long-continued waste. For the majority of mankind, Nature provides for the adjustment between consumption and reproduction of brain-matter by the alternations of day and night, noise and silence, society and solitude, and also by the substitution of the play of fancy in dreams for the work of the judgment and the will in waking hours. We follow the lead of Nature when we seek amusement as a remedy for care. We bring into activity a rested portion of the brain, to permit the wearied parts of it to restore themselves unhindered.

This is the *rationale* of the pathological treatment of the brain. Tell an overworked president of a railway company, who falls asleep at the directors' meeting, that he must *rest*, or die of softening of the brain, and he will smile a sad reply that he *can not rest*. He is right, thus far: he can not rest his whole brain, but he can rest the cerebellum—the seat of the will-power—by bringing into higher activity and more frequent exercise the upper and frontal lobes. Let him stop thinking of leasing rival lines, and read novels and play billiards. Let him ride some youthful hobby, revive his practice on the violin, cultivate flowers, keep a stud and kennel, bury himself in Greek and Latin literature, collect pictures, minerals, do anything which will really interest him and keep him out of the way of railroad men and railroading, and do it with his might, with enthusiasm, even to fatigue, and do it for at least four years, and by that time his cerebellum will be all right again.

Now, what the unintermitting responsibilities of the railroad official do for the destruction of the constitution of his cerebellum, just that the overstrained exercise of the creative imagination does for the demoralization of the brain of the man of science, especially if it be as it commonly is, accompanied by business anxiety. And his only way of escape from a predestined break-down is through the monotonous but interesting occupation of his perceptive faculties in the field and at his office-table. In both he will enjoy that solitude which resembles sleep in being a medicine for the weary brain. But it is a solitude peopled with unexceptionable friends—in which Care sleeps and Pleasure wakes—a solitude in which the soul multiplies itself by alliance with all the possibilities of number and all the actualities of form; a solitude from which a man returns to the society of his fellow-men sainted by the blessing of Nature and equal to the duty of existence.

In conclusion, I must express the wish that this meeting of our association may be as delightful and as useful as any that it has ever held. Those who remember how hard we used to work at them, what a harvest of mutual confidences we used to gather at them, and what a glow of fresh enthusiasm we carried away with us from them, will know what such a wish implies. Those who come fresh to this meeting will find themselves made at home in half a dozen worlds of science at once. That is the particular character and special charm of this association, wherein it differs from all local societies, and from all conventions of workers in special branches of science and art. And, as each meeting furnishes a panoramic view of the present state of human knowledge as a whole, so, at each meeting, the old and the young in science are mingled in such friendly and confidential intercourse that the prospect extends both backward to the beginnings of inquiry and forward to its possible achievements. All good tradition is precious; and so is well-trained current inquiry, and so is sound prophetic calculation. At such a meeting as this, we enjoy the rare privilege of assisting at all three; and, when we scatter to our homes, we can hardly fail to take with us something effectual for lightening and sweetening another year of work.

THE SOCIAL LIFE OF ARCTIC BIRDS.

By Dr. ALFRED E. BREHM.

"WHEN the great architect of the universe had finished his favorite star, the earth, Satan aspired to destroy it. From the seventh heaven he slung down a great stone toward the blooming earth ; but an archangel, witnessing the wicked act, flew down faster than the falling rock, and turned it aside. The stone fell away up in the Northern Sea, and was broken up. The fragments scattered on every side and formed cliffs, some of which sunk in the deeps, while others rose black out of the waters. God in his infinite mercy pitied the bare devil's rock and made it fruitful." Thus runs an ancient Lap legend. The rock is Scandinavia ; the fragments are the innumerable islands that surround it ; and the fiords are the clefts between the larger stone and the fragments. One should have seen the country, rowed through the fiords, and gone down the icy mountains to the lakes and bays, to appreciate the appropriateness of the Saga.

Scandinavia is an Alpine country, and has, like Switzerland and the Tyrol, majestic glaciers, musical, dancing mountain-brooks, and strong rivers rushing over the blue slopes which are reflected in the transparent dark lakes. High up among these lie the prettily poised dwellings of the men, like eagles' nests stuck to the rocks. To make the similarity with the Swiss Alps complete, the green meadows are also not wanting in Scandinavia ; and, while the northern mountains do not resound with the exultant jodel, joyous, fresh, melodious songs may be heard in the valleys and on the heights. The difference between Switzerland and Scandinavia is nevertheless great, even if we only consider how the deep sea cuts into the land and forms large bays which receive, from the shadows thrown upon them by the dark surrounding rocks, a mysterious yet not fearful aspect.

The fiords of Norway are remarkable, but they are not the most peculiar feature of the country ; this is found in the innumerable islands which rise more than a thousand metres above the sea, or, planting their roots in the boundless deep, are visible only at low water. These islands are charming in the highest degree, and their peculiar beauty approves itself when the sun is resting below the horizon at midnight, and only a breath of twilight sweeps over the masses overflowed by the water. One might then well believe himself in a scene of enchantment.

The farther the traveler advances beyond the polar circle toward the north, the larger and more comfortable are the houses, while in the south, where the population is denser, they are of slighter construction. Yet no furrow is turned, no scythe is swung there ; the sea is the field from which man derives his living. At the parting of day and night, when the sun goes away for months, the men sail recklessly in their boats and canoes to their anchoring-places far up in the north, and their spacious houses are quickly filled with guests. Obeying the resistless drift, come hosts of fishes out of the deepest deeps of the sea, so that the net cast for them mocks the strength of the Herculean men, or is torn under the burden. The throng of the foolish fish is so dense that an oar pushed perpendicularly through it remains upright. Millions are caught, and millions go on, so that there is no sign of a decrease in the number. This migration of the fishes reaches its extreme point at about Christmas-time. No pencil could reproduce the picture which the polar sea exhibits at this season. Hundreds of craft, manned with stalwart fishers, are being incessantly filled with speckled prey; as far as the eye can reach, nothing but fish, which crowd and press upon one another to get to the breeding-place; the massive glaciers and rock-built shores in the background, and, as illuminants to the scene, the ghostly moon and the crackling northern lights. All this time there is also twilight on the southern horizon, and toward February a narrow strip of the sun shows itself again, gradually to rise higher. With the first appearance of day the fishes begin to sink slowly in the fathomless depths. As the sky becomes brighter, the sea and its bays become more quiet. The boats cease to glide over the surface of the waters, the fishermen go home with their spoil, and the northern world lies silent, basking in the beams of the returning sun. But this quiet only lasts for a few weeks, when new noisy, swarming hosts come to the islands. They are the birds, which come up from the sea to the land. It is a deeply poetic trait in the lives of these creatures that only two causes determine them to seek *terra firma*—the power of love and the approach of death. The sea-bird, weather-proof, lives on the sea. He hunts his food by diving, swinging over the billows, and sleeps and dreams with his head hidden under his wings. But there comes a time when the earlier sunbeams kiss the northern islands; then he is mightily moved in his soul, and hastens to the coast to celebrate there his annual wedding. And, when he feels that death is near, he swims with his feeble limbs back to the place of his birth, there to close his life. It is the same feeling that inspires in aged men that ardent desire to return to their old home to die and be buried there. To the naturalist who goes to the north to study the ways of the birds this trait in their character is of peculiar interest. Of one of the tribes of these colonists of the northern bird-mountain I must make particular mention. It is the eider-duck, the producer of down. It belongs to the family of the ducks, and forms, so far as bodily stature is concerned, one of the largest species of the group. The plumage of the male is handsome and brilliant. In it black, red, ashen-gray, ice-green, white, brown, and yellow are mingled with splendid effect. His head and back are snow-white, his neck is rose-red, and the lower part of his body is deep black. The female is less richly colored, in a modest garment adorned with gray and black spots and stripes. The eider-duck is a real sea-bird, and is excelled by none of its fellows in diving, while no other bird is more awkward in flying and helpless in walking. On the ground it moves with a toilsome waddle, stumbles and falls flat; and it greatly prefers the fluid element to the solid land. The birds generally live during the winter in large flocks on the open sea, and feed themselves with shell-fish which they bring up from the bottom. But, as soon as the spring sun begins to shine over the waves, the drake feels newly awakened the old love in his heart for his mate, and he renews his wooing. One pair after another leave the host and swim steadily toward the land. This wedding-journey toward the breeding-place offers a pretty picture of conjugal life. From the moment when the pair have found one another again there rules only one will, that of the duck, to which the male yields fully and without any wavering. Quite noticeable are his courteous attention and tenderness toward his spouse, which Madame Duck takes, as matters of course, in calm dignity. She steadily makes toward the shore, and finally lands, hardly heeding the cautions of her mate, whose instinct, sharpened by the experiences of former journeys he may have made, prompts him to beware of the devices of men. Loyally he waddles into the country, and follows her in her interminable tours while she is looking for a suitable nesting-place. Madame shows an exceedingly dainty taste during her explorations, carefully examining every bush, shrub, stone, and protected spot, venturing without fear into the dwelling-houses, even into the kitchens and chambers, where, if she finds a spot to her taste, she does not hesitate to take possession of it. Occasionally she will fix her nest in the oven, leaving it to the worthy matron of the establishment to find another place to bake her bread. The thrift of the woman generally gets the better of her vexation, and she lets the fowl alone so as not to lose its down. The nest is quickly built. The foundation is laid with dry grass and straw, after which the duck strips herself of down and forms with it a thickly soft-cushioned bowl. The drake follows every step of his mistress during these excursions and preparations, and looks out for her safety, without, however, "lending a hand" in any of her labors. As soon as the eggs are laid he deserts nest and mate and flies off to the sea to join the other males again. Great throngs of these grass-widowers may then be seen sailing among the islands, wholly unconcerned about what is going on on the mainland. But we shall see how soon they are driven from this careless life.

The duck lays from four to eight, sometimes indeed ten grayish-green eggs, and then begins to sit upon them. The Northmen have been only waiting for this time to gather their spoil. Thirty ducks' nests furnish a pound of down, which can be sold on the spot for thirty marks German or $7.50 American money. The eggs are also worth money, and are generally sent to England. A duck-colony of this kind is a capital, the income from which is all clear gain, for the bird feeds itself and costs nothing. As soon as the eggs are laid the Northman appears with a great basket, into which he puts nest and eggs. The duck is deeply distressed over this unrighteous seizure of her property, and in her inexpressible agony flies out to sea to seek comfort with her mate. Whether he receives her with tender expressions of sympathy or with scoldings for her neglect of his warnings is still an unsolved problem; but it is certain that he becomes tender again toward her, and after a few weeks waddles back behind her to the same bay where she had been so badly treated. She again gathers straw and grass for the new nest; but how about its warm lining? The new down has not grown upon her in so short a time; what shall she do? There is no mother, not even a duck, that can not find her way out of a difficulty when the question concerns her offspring. Her breast is indeed bare, but her mate still has his full coating of down, and is now obliged to sacrifice it on the altar of affection. He cheerfully adapts himself to the unavoidable, and begins to strip himself. The process does not go on fast enough for the impatient duck, and she helps in the work, and both persevere in it till the drake stands out entirely bald. Then he flies away, and troubles himself no more about wife and nest, an indifference for which we need not blame him in view of his own forlorn condition. The duck herself also thinks of only one thing—her brood. She leaves the nest only once a day for a little while in the morning, to take her bath in the sea, plume herself, and get some food; but while attending to these details she does not forget to cover the eggs carefully with down, so as to keep them warm. Danger no longer threatens the brood from man, who generally takes good care of this hatching to preserve the species; but it is likely to come from birds of prey. Under these circumstances the practical value of the duck's simple duskily speckled coat is fully demonstrated. The color of its plumage agrees so well with that of the ground that it is very hard to distinguish the bird from its surroundings. It has happened to me more than twenty times to be standing directly over a nest and not remark it till I felt a gentle pecking at the feet, which the bird gave me by way of warning that I was approaching too near; for the duck hardly ever thinks of flying from man during the time of its brooding. I have frequently bent down over a nest, stroked the bird, and felt the eggs without its rising. The most it would do was to snap, as if in play, at my fingers.

A characteristic trait of the eider-duck is to have as many eggs as possible, whether they be its own or strange ones; it is a trait that is not found to exist to so great an extent in any other being. The sitting birds steal one from another whenever they have an opportunity. It is no uncommon occurrence, when one of them is away from her nest for a little while, for her neighbor to purloin three or four eggs, carry them to her nest, and hatch them out with her own. The robbed duck discovers the theft immediately on her return, but gives no sign of concern about it, seeming to say, "We will wait till you go away, and then I shall take my revenge." Her time comes at last; and thus no duck knows whether it is sitting on its own eggs or another's.

The young come out from the eggs at the end of thirty-six days, but do not stay in the nest any longer than till they have become completely dry, when the mother takes them to the sea, which she does not leave till the young have become tired in this their first swimming-lesson, and can no longer ride on the backs of the strong waves. It is usually a considerable distance from the nest to the shore, and the chicks are exposed to many enemies in the shape of hawks, ravens, and gulls, which keep an eager lookout for them. Now the Northman steps in with his protecting hand and comes along with a pair of large baskets, into one of which he puts the young birds and into the other the precious down, while he goes from nest to nest, examining them to see in what ones the brood is ready to be removed. Hence he takes the young ones to the sea, while the mother waddles along behind, well knowing where he is leading her. At the shore he turns the basket over and goes away, leaving it to the old birds to find their own. They plunge into the flock, and each speedily gets as many of the chicks as she can. After a few hours the family bonds are closely sealed again, and each mother has gathered her little ones around her, which she treats with the most tender care, while they in return show the most grateful affection for her. They go with the old ones into the water, crawl around on their backs, and receive instruction in swimming and diving for mussels, the mother in the last exercise going down with a chick under each wing. In the course of eight weeks the young become fully instructed, and are ready to begin the struggle for existence on their own account. Now appears the Herr Papa again upon the scene, when there is nothing more to be done, and proudly conducts the whole company over the open sea to their winter home. Such is the history of the best-known and most interesting of the birds that people the mountains of the North. I have thought it proper to give in brief a clear picture of its habits, because it forms in some respects the central point of the motley, busy company. We will now sketch in broad outline a general picture of one of these bird-mountains.

The storm-gulls are inseparable from the eider-duck. If there are ten thousand pairs of ducks on a mountain, then the number of gulls nesting there will be at least fifty thousand. They come rushing up in graceful, rapid flight, presenting a pleasant aspect with their snow-white and dark-colored feathers. They are the real but innocent betrayers of the eider-colonies, for where gulls circle in great numbers around the island one is sure to find nests of down. The host is further increased by large flocks of a kind of snipe which are distinguished by their clear voices. They are the police of the mountain, the guardians of the safety of the bird-republic; for as soon as they perceive anything that betokens danger, say an approaching boat, they cry out in chorus and give an alarm that instantly sets the whole population in motion. The gulls immediately send forth scouts which go toward the boat, soaring, screeching around it, swooping down upon it with the speed of an arrow, and often touching the boatman with the tips of their pinions. The mass of the army follows the scouts. They come by thousands and thousands, in so thick masses as to obscure the sun. The explorer is forced to come to the shore veiled in this living, fluttering, screeching, rushing cloud. The ducks, if they are not actually sitting, fly, the snipes hastily seek the sea, and the wagtails follow in noisy flight, but the host of gulls stands firm, screams and bustles and whirls and plunges, as if it could prevent the advance by noise and sham fighting. One may walk the shore and see nothing but birds and nests, and hear nothing but the discordant din of voices, accompanied by the thunderous rushing of thousands of wings lashing the air.

A more quiet picture is afforded by the hill where the auks brood. They resemble the eider-duck in shape, except that their bills are sharp and not flat, like those of the latter. There are three species of them, which are distinguished from one another by the length of the bill and its curvature. All three species live and brood in the same places. I was told of a mountain where a million of them had built their nests. I am sure of one thing—that no man has ever seen a million birds, even though he has traveled over half the earth. Doubting the accounts, I visited the described mountain. On a bright summer day my companion and myself took a boat and rowed toward it, over the smooth, transparent water, between beautiful islands, followed by the screeching of the startled gulls. High above us on a towering ridge we saw the watchful ospreys; by our side, on right and left, along the shore-cliffs, the sitting eider-ducks. Finally we came to the populous part of the mountain, which is from three hundred and twenty to three hundred and thirty feet high, and saw really immense numbers of birds sitting on the ridges. The higher parts of the cone were covered with a brown spoonwort, and as we approached the shore the birds drew back thither, and suddenly disappeared from view as if by concerted agreement. When we had reached the shore and landed, and were wondering what had become of the hosts of birds, we found the ground burrowed all over with holes that looked like common rabbit-holes. We soon learned that they were the entrances to the nest-chambers of the auks. The holes are large enough to permit the birds to pass through, and then widen on the inside so as to give room for the nest and the two birds. As we climbed toward the height, the tenants first carefully and anxiously peered at us, then slipped out and threw themselves screaming into the sea, which was soon covered, as far as the eye could reach, with birds whose cry resembled the noise of a gigantic surf or of a raging storm. At last we reached the top of the mountain, where two falcons that had been soaring over our heads swooped down like arrows into the swimming mass; each seized an auk in its claws, and then rose slowly toward the clouds. But the sea extended its wide, dark blue, bare surface before the eye, for the white swarm of birds had disappeared, having dived down beneath the protecting waves. After one or two minutes one arose, then a second, and a third, and so on in quick succession, and, as they thus gradually appeared on the surface, they looked like flecks of white foam. With marvelous rapidity the little dots increased, till soon it was only here and there that a strip of water could be seen. The screeching began anew, and the birds arose again from the water and moved toward the heights. We had sat down; the rustling, like that of the surf, and the monotonous cry of the birds, had lulled us gradually into a deep sleep. When we awoke and opened our eyes we could have believed that we were transported into a fairy land. In numbers like the sand on the sea-shore, the auks were squatting at our feet and down to the edge of the water, and curiously looking at us. We were the giants of the fairy story; they were the dwarfs, who dwelt in the secret caves of the mountain. The millions were there, if one could judge by the eye alone, but it is probable that, on an exact count, they would be many thousands short.

The auk lives a life of strict monogamy. It is to his beloved old wife, the flame of his youth, that he gives his attentions on every returning spring. The old auk is a constant, loving spouse, a pattern of a husband, and it is really a pity that the numerical relation of the sexes is such that not every young male can mate himself, and many are compelled to wander through life in compulsory bachelorhood. Particularly painful is the condition of the solitary one when the pairs go to the mountain in the spring. What shall he do? Shall he alone or with other morose companions wear out his life on the high sea? No, that would be suicide. He follows the bridal trains to the mainland and has at least a happy company around him, and may always hope that one of the males may perish, and he then in some possible way find favor in the eyes of the widow. The auks return every year to their old nests, which they readily distinguish, and the young, newly mated pairs build themselves new nests, or take possession of old ones whose owners have gone the way of all flesh. The male keeps watch at the entrance, while the female sets the house in order and lays her single egg, which is sat upon for about three weeks and a half. The female sits twenty-one hours a day, and the male ought to sit three hours, but he never does it, at least not in the beginning. As soon as the female goes away he rushes after her in a spasm of jealousy, for the young fellows are lurking around in all the corners and at all points. But this neglect of duty by the house-tyrant brings no harm to the egg. The nearest young fellow nimbly slips into the nest, and keeps the egg suitably warm till the mother returns. Shall he not also have a little satisfaction when others are sipping the joys of life in full draughts? There are no orphans among the auks. If a pair happen to die, the young fellows will hatch the egg out, or, if the chick is already hatched, they will take care of it. The early instruction of the chick is a matter of patience, time, and trouble. As soon as it is dry, the parents take it to a cliff by the sea-shore and spring down, while the young one remains standing above and not knowing what to do in his helpless condition. The old ones call, but he does not follow, for he is afraid of the leap and of the strange element. Father and mother repeat the leap again and again, and encourage the timid one. The young bird follows at last, not venturing upon the leap, but in a kind of desperate mood letting himself fall. As soon as he has touched the swinging wave he feels at home, and begins to swim bravely, the parents keeping by him, so as to give him rest on their backs when he is tired.

A quite different spectacle is presented by those mountains which are principally inhabited by a particular species of gull. To observe one of them I made a special excursion into Lapland. I had at the time a design of writing a book on the life of birds, and had read in some work about three-toed gulls that nested in the bird-mountains in such multitudes "that they darkened the sun when they rose, completely covered the mountain when they sat down upon it, deafened the ears when they screeched, and turned the verdure-clad rocks white where they were sitting." There are only three such mountains known —one in Lapland, one in Iceland, and one in Greenland. The one in Lapland, which is much the most remarkable, lies out of the course of the steamer, and we were therefore obliged to charter a special boat to reach it. A storm compelled us to go into a harbor of refuge. When the tempest had abated, about midnight, we continued our voyage. The waves were still high, and single gulls shot before and around us like dazzling white flashes. All at once, at Cape Svaerholm, not far from the North Strait, there rose before us a great black cliff. It looked like a large marble table covered with millions of little white points that shone like stars. We fired a shot at them, when, as soon as the report had ceased, these became living birds, pure white gulls, and sunk in a few minutes hastily down to the sea in so compact a throng that I might have thought a snow-storm had broken loose and was pouring its immense flakes down from the sky. For a few minutes it snowed birds as far as one could see. The surge rolled wild, but it was the euphonions accompaniment of the rustling of the wings and of the shrieks of the frightened sea-birds. As far as the eye could reach the waves were covered with the foam-born children of the sea, and the cliff and the mountain were as white-dotted as before. Yet these were only the males, which had rushed away on the approach of danger.

NEUTER INSECTS.

By CHARLES MORRIS.

IN the later editions of Darwin's "Origin of Species" he has answered with remarkable ability nearly all of the several weighty arguments brought against his theory. Some seemingly insuperable objections have been met with an array of facts before which they quite break down. Thus, several instances of extraordinary organs in certain species or types of animals, which it was claimed could not possibly have originated through natural selection, he has shown to be connected by intermediate variations with ordinary organs, which variations are useful at every point of their development, so that the strange appendages might easily have arisen through minute gradations of change.

There is one objection, however, which he can scarcely be said to have answered so happily. This is that in reference to neuter insects —the specially developed working-ants, for instance. As he himself acknowledges, the phenomenon of neuter insects appeared to him at first insuperable, and actually fatal to the whole theory, since these neuters often differ widely in instinct and structure from the males and females, yet, being sterile, they are incapable of hereditarily reproducing their characteristics. In working-ants the difference from the sexual forms is often very great, as in the shape of the thorax, the lack of wings and sometimes of eyes, and in instinct. The difference in instinct is still greater in the hive-bee. Nor is this the whole of the difficulty. In some species of ants there are two and even three distinct castes, well defined, and each with specialities of structure.

Yet, as it is quite impossible that these sterile females could transmit their peculiarities to descendants, and as no such peculiarities exist in the structure of the males and developed females, hereditary influence would seem to vigorously oppose their reproduction, and it seems quite extraordinary that the sexual forms should produce offspring so markedly unlike them. The case is as remarkable as if the offspring of a lion and lioness should be a cat or a leopard, or if a sheep should produce an antelope.

Darwin seeks to explain this difficulty by considering that selection may apply to the family as well as to the individual, and that chance peculiarities of structure, which proved useful to the community, may have been preserved by selection, the tribes in which such useful aberrant forms appeared surviving, while tribes more normal in reproductive power perished. Illustrative facts tending in the same direction are given, and there is certainly a degree of force in this argument, though it can scarcely be accepted as wholly satisfactory.

It is probable that Darwin did not give to this question as full a consideration as to many others, or his remarkable power of analysis could not have failed to perceive other important bearings of the subject. A full review of the phenomena of larval development certainly seems to remove the mystery of the neuter ant and bee from the position of an anomaly to that of an ordinary method of structural unfoldment. If the appearance of sexual organs and powers is the final step to maturity, then all neuters are larval forms, although in every other respect their development may be complete; and they are subject to the same modifying influences as are all larvæ. It is one of the most common conditions of invertebrate life-development for the unfolding offspring to stop at certain stages of growth, and devote itself for a while to nutrition, ere resuming its course of structural development. Such "resting-stages" are those in which there exist specially favorable conditions of nutrition, or of adaptation of the larval form to the conditions of the food-supply. The most notable instances are those seen in the extraordinary larval forms of some of the Echinodermata, and the little less remarkable larval structure of some of the insects and crustaceans. In certain cases several successive larval forms, each deviating considerably from the normal type of the animal, appear.

Yet these peculiarities of structure have never yet been advanced as stumbling-blocks in the way of natural selection. The caterpillar, for instance, while resembling the moth or butterfly in its more deep-lying peculiarities, displays remarkable external deviations, and assumes organs and instincts still more anomalous than those shown by neuter ants. The larval star-fish presents an instance of still stranger anomaly. Only the stomachal region and its immediate surroundings pertain to the type, and all the rest of the structure is accessory. When the development of the star-fish is resumed the new form grows out of this internal region of the body of the bipinnaria, or larval form, whose external parts are discarded as useless, or absorbed as food by the new creature. This is the most aberrant instance of such temporary development known. No trace of the star-fish type can be perceived in its larva. It doubtless exists, but is quite masked by secondary formations. Or it may be that this larva represents an ancestral form of the star-fish, as divergent in character as is the crustacean larva of the barnacle from the mature form.

Yet this explanation of atavism, or temporary check to development at an ancestral form stage, only partly meets the difficulties of the case. There is an unquestionable new adaptation to new circumstances to be explained. Natural selection acts upon all forms which give it sufficient opportunity, without regard to whether they are larval or mature. Let us take for an instance the case of the butterfly. Here the development does not proceed continuously, from the germ to the mature form, as in some insects, but is checked for a considerable period at the caterpillar stage. The active nutrition at this stage seems to act as a check upon development, so that the caterpillar is a form upon which natural selection has full opportunity to produce its effects. Originally it may have simply rested for a time in the direct line of development, on account of finding abundant food. But, as food conditions changed, new enemies attacked it, or old foes adopted new modes of assault, one of two things was necessary for its survival. It must either lose this resting-stage and develop continuously, or it must become adapted to the new conditions. This rendered necessary changes in instinct and in structure. Where the resting-stage, as in the caterpillar, occupied a very large percentage of the total life-duration, and where the process of adaptation had millions of years for its completion, it is not surprising that structural features often very divergent from the typical form were assumed.

There is little or no reason to doubt that all the peculiarities of larval form are due to the two causes here specified: 1. A temporary check to development at some ancestral stage of the animal's unfoldment. 2. An adaptive modification of structure and habit to meet varying conditions in the environment of this stage of development.

Yet in every such case we meet with a difficulty of the same character as that existing in the case of neuter ants. These secondary adaptations are out of the direct line of the animal's development, and it is a question how they can be hereditarily transmitted. The law of phylogenetic development enables us to understand the appearance of certain embryonal peculiarities of structure which do not exist in the mature form. If development is forced to follow its original line, such ancestral features must necessarily appear, though if the development is very rapid only hints of them are perceptible; or they may become utterly obliterated, so far as our powers of observation can decide. Yet such a principle can not apply to secondary structural features, produced in larval adaptation. The latter are in no sense in the direct ancestral line of development, and it is somewhat remarkable that they are so faithfully reproduced, only to be thrown aside again as the animal resumes its temporarily checked development.

It is very evident, from the facts here cited, that the phylogenetic line is subject to disturbing influences. There is no special reason, in the nature of things, why a developing animal should repeat every stage of its ancestral growth. If never disturbed in its development it would naturally do so, since its original evolution from primeval matter lay in that line, and there has been no force since brought to bear upon it to make it deviate. But where any subsequent force causes deviation, that deviation must become persistent. There can be no possible return to the exact ancestral course. Many such deviations have occurred. Some of them are only apparently such, arising from rapidity of development, and the slurring over of intermediate steps in the line of growth. But many of them are results of subsequent adaptation. Such is the case with many of the peculiarities seen in the unfoldment of the mammalian embryo. It has deviated from the ancestral line to meet certain special requirements of the situation. It can never return to that line. The mere fact that an ancestor once existed, with certain characteristics, has in itself no controlling force upon the development of the embryo.

The secondary adaptations of larval forms have the same bearing upon development as have peculiar ancestral conditions. They become characteristic steps in the line of development to maturity. The sexually mature animal has passed through them all in its growth from the germ, and conditions of the same character are implanted in its own germs, and must unfold in their development. There is no longer an exact phylogenetic line. Many of the ancestral stages have become greatly modified. To the new developing animals those modified stages of growth are ancestral stages so far as it individually is concerned. Development follows this new line, although it may have become a strangely warped and irregular one, and though at certain stages of growth it may yield peculiar organs or tissues which are discarded as useless, or consumed as nutriment, at later stages. The true line of growth in such cases is restricted to the more deep-lying and important parts of the organism, and though, at certain stages of growth, forces appear which produce a special growth of secondary tissue, this is reabsorbed or discarded when the development is resumed. Marked instances of such discarded tissue are seen in the pupal development of certain insects, and in the case of the star-fish development above referred to.

We have paid some little attention to the characteristics of larval growth for two reasons. Their true bearing on the mystery of evolution has been little attended to, and the above-given hypothesis of explanation has not heretofore been offered, so far as the writer is aware. The second reason is that they bear a much closer relation to the phenomenon of neuter insects than might at first sight appear. The neuter insect has not as yet been looked upon as a resting-stage in the line of full development, and as analogous to the lower stages of larval growth. It has, indeed, a peculiarity of its own, that it fails to attain full development. And as its secondary characteristics are not participated in by the sexually mature form, but have arisen by adaptation which is still operative, the fact of their transmission becomes difficult to understand. Yet we think it may be shown to be but an extension of the principle above considered.

It is a significant fact that a neuter worker class is found only in those animal tribes in which the social principle has reached its highest development, such as the bees, ants, and termites among insects, and the hydroid polyps in the other sub-kingdoms of life. In each of these communal types of life there has been a division of duties, the work of reproduction being confined to one or a few members of the community, at least so far as maternity is concerned, while the other members have gained special adaptations to other duties. In bee communities only one queen is permitted to develop, while the remaining females continue sterile, and become adapted to working duties. Among the ants numerous queens develop, but each surviving queen usually becomes the mother of a separate community, in which the sterile females are adapted to two or more distinct duties. The problem of the males is a singular one. Among bees and ants they are never checked at the worker stage, but develop to become a possible burden on the community. Here among the bees a second remarkable instance of intelligent selection is displayed. The males are suffered to live as long as food is abundant, but are mercilessly stung to death as soon as there is danger of lack of food. In ant communities natural selection disposes of the surplus males. Their life-power is reduced to that required for the nuptial flight, and they die as soon as their one necessary duty is performed.

Among the termites, or white ants, we find an interesting extension of this principle. Here restriction applies to both sexes, the workers and soldiers being immature males and females. Some writers, indeed, hold that they are of no sex, but have been checked in development at the larval stage, before sexual differentiation began. And a male as well as a female survives to start the new community, each nest having its so-called king and queen. In polyp colonies we find the same thing in a less developed stage. Each sexual individual is hermaphrodite, and the king and queen powers exist in a single form. In the *Siphonophora*, or floating hydrozoan colonies, the partly developed forms are adapted to four distinct duties. Some of them become contracting bells, and serve for locomotion; others become stomachal tubes, and digest the food of the colony; others are tentacles, or food-catchers; and others are simply covering or protective pieces; yet in all of them the *Medusa* type can occasionally be recognized.

It may be well to point out here that a similar division of duties exists in all the higher members of the vegetable kingdom. Each tree is a colony, the product of buds arising in a common stem, and is thus closely analogous to a polyp colony. The analogy goes further—there is a division of duties among the members of the tree colony. Some of these members attain full development and become hermaphrodite sexual individuals. The others are restricted in development, and become adapted to several distinct duties. Thus, two distinct nutritive forms appear, the leaf-bearing individual and the root individual. But greatly restricted protective forms occasionally appear, such as the thorn, whose development is on a level with that of the covering-piece in a polyp colony. Other illustrations of this principle of restriction of development and division of duties might be given, but we must go on to consider its significance.

If we consider any of the lower animal forms, it will quickly appear that structural development is checked more or less completely during active life and abundant nutrition. Insect larvæ, for instance, simply grow during their active feeding-stage. New development only begins during the inactive pupal stage, in which the tissue formed during the larval stage is modified and transformed. After the insect becomes again active, as the imago, no further development of special importance takes place; and it would appear that, if the larval stage is not allowed its full period or its complete course of nutrition, the pupal development is checked at an imperfect stage, and the imago remains immature.

Such is evidently the case in bee communities. The division of the community into males, queen, and workers seems less an operation of natural selection than of intelligent selection. It is a matter of choice among the workers whether any female larva shall develop into a worker or a queen. By giving more room for growth, and more and better food, they can produce a queen from any female larva chosen at will. By contracting the growth-space and diminishing the food, the power of development is checked, and the insect, in its pupal stage, becomes incapable of developing sexual organs and powers.

Thus in every female larva it seems evident that innate powers to become either queen or worker exist. The queen is the higher phase of development, but in attaining this stage the worker stage must be passed through. Why does it not become apparent? This is not difficult to understand, since a similar phenomenon is of very common occurrence. It is simply slurred over in a rapid course of development. The sexual organs begin to unfold, and in so doing exhaust the nutriment and the life-energy which would be needed for the full unfoldment of the worker organs. Thus the superior force checks the inferior, and the innate tendency to develop into a worker is overcome by the activity of a more energetic innate tendency. Where the latter remains aborted the worker tissues fully develop, and with them the worker instincts, since every stage of structural development seems accompanied by its peculiar instincts, as if tissue dominated instinct.

In the case of the ant we have closely similar phenomena. Here there is no satisfactory evidence of intelligent selection, though many observers believe that it exists. So far as we know, however, chance decides whether the larva shall have food enough to carry it to one or other of the worker stages, or to the queen stage. Thus numerous individuals of each stage appear. But the two or more worker castes are not completely separated, since intermediate forms exist, sufficient to make a line of insensible gradation from one form to the other or others. Here, then, we have a complete line of development, reaching from the germ to the queen, but checked at various stages, in which nutrition becomes active and secondary adaptations appear. These secondary adaptive features have undoubtedly become part of the direct line of structural unfoldment. But, as soon as a higher phase of structure begins to unfold, these lower conditions of tissue are broken down or reabsorbed, just as in the human embryo the gill-arches disappear, or are transformed into organs required in the next higher stage.

If, in the insect pupal stage, the development of the higher structural stage begins simultaneously with, or immediately after, that of a lower stage, the latter is interfered with by a superior energy. It can not obtain full unfoldment, and may gain but a rudimentary formation, which may be immediately reabsorbed, to answer the demands of the superior modifying energy. Two unlike energies seem fighting for the nutriment, and the stronger wins. Instances of this principle of development are common in embryo growth, and act to check or to completely abolish the unfoldment of ancestral features. In the case of the ant we may look upon it as the cause of the lack of appearance of the worker characteristics in the development of the queen, and of their full development where the conditions are such as to prevent the innate powers of sexual unfoldment from coming into play, and to restrict development at a lower level. It need scarcely be added that in the case of these insects the check to development is final. On leaving the pupa-case, they enter upon a life of active nutrition, in which the powers of development already in operation may produce their full results, but in which the latent higher powers are definitely restrained. In all cases of insect development, and doubtless to a certain extent in all animals, a state of passivity is requisite to active transformation of tissue, while simple growth is the prevailing tendency in states of activity and abundant nutrition. In these latter states organic development may proceed, but it is simply the completion of lines of development which began in the passive state. New lines of development do not begin during nutritive activity. Of this principle many illustrations might be given, had we the space here to adduce them.

In the case already cited, of the hydroid polyps, this principle of development yields some remarkable results. In many instances the sexual individuals unfold into the full medusoid type, and leave the colony to enjoy a free life. In others they remain attached to the colony, and are more or less checked in their full development. This check to development is so great, in certain instances, that a mere bud appears, to bear the generative products. Thus the sexual, instead of being the typical form, remains as a formless protrusion of the polyp stem, or the germs may originate in this stem with no form development.

Yet this seeming anomaly is not without its explanation under the above principle. Where free Medusæ are produced, the sexual organs and products do not appear until after full development and freedom from the colony are attained. In the other cases mentioned the generative products appear earlier, and it is probably their appearance that checks further form development. The innate tendency to develop the medusa form is hindered by the early unfoldment of the superior tendency to sexual development, which exhausts the vital energies and absorbs or prevents the formation of other tissue adapted to the lower life-purposes. The needs of this highest life-power tyrannize over all lower powers, and as soon as it appears all other development ceases. In most animals it is the final step, after all lower stages are completed. Here it is occasionally the initial step, and exhausts the developmental powers before any of the lower stages have appeared.

In plants the same principle holds good. Active nutrition checks development, and unfoldment ceases at the leaf or the root stage. For full development, nutrition must be checked; when a partial resting-stage succeeds, higher transformation sets in, and the sexual bud or the flower individual appears. In many cases hints of the leaf stage of development are displayed. In others this stage is completely aborted. Thus the leaf-bearing individual, in its lack of power to reproduce itself, and in its structural and functional differences from the flower individual, is closely analogous to the case of neuter insects as compared with the sexual forms. In plants, also, we have instances of the aborted development of the sexual forms, closely analogous to those seen in the Hydrozoa. Thus, in these remarkable phenomena of development there seems to be a close relation between the tenants of the two great kingdoms of life.

MASSON'S INTERPRETATION OF CARLYLE.*

THERE is nothing sadder or more painful in the history of literature than that eclipse of the reputation of Thomas Carlyle which resulted from the publication after his death of various books, biographic and autobiographic, which came as a new revelation of the inner life and personality of the great author. Professor Masson, of the University of Edinburgh, was one of his old and intimate friends, and one of his most ardent admirers. It was but natural, therefore, that when the great reaction came, so injurious to Carlyle's reputation, his friend should find himself called upon to say something in vindication of that apparently much-damaged reputation. Professor Masson's two lectures, delivered before the Philosophical Institution of Edinburgh in February of the present year, give an extremely interesting view of Carlyle's character, opinions, and labors, and certainly go far to vindicate him from much of the reproach that fell upon his name through the publications that quickly followed his death. We have

* "Carlyle Personally and in his Writings." Two Edinburgh lectures by David Masson. Macmillan & Co.

no room here to state the case as fully as it is presented in these lectures. Mr. Froude was the official custodian of all the Carlylian documents, and held the great man's reputation in the hollow of his hand. Professor Masson is justly severe upon him (as have also been many others) for his lack of sympathetic discrimination in dealing with the private expressions of his deceased friend, and giving to the public much to which it had no right, which was undoubtedly never intended for publication, and which was an inexcusable outrage upon innocent persons. Mr. Froude was incompetent for his editorial task: though an intimate and life-long friend of Carlyle, he was constitutionally incompetent to understand and do justice to his character. This is well illustrated by the following passage from Professor Masson's first lecture:

"Another cause which has contributed not a little to the unhappy general effect of the nine volumes is the prevailing somberness and lugubriousness of those portions of them which come from Mr. Froude's own pen. In the 'Reminiscences' and the 'Letters and Memorials of Jane Welsh Carlyle' these consist, of course, but of casual editorial notes and explanations; but, in the four volumes of the 'Biography,' they form the text of narrative and comment in which the fragments of documentary material for all the eighty-five years of Carlyle's life are imbedded. Now, wherever Mr. Froude himself thus becomes the narrator or commentator, his mood is too uniformly like that of a man driving a hearse.

"The contrast in this respect between what is from his own pen and much of the documentary material he digests and edits is very remarkable. There is gloom enough, seriousness enough, in the matter of the documents; but they are not all gloomy or serious. They abound with the picturesque, the comic, the startlingly grotesque, or the quaintly pleasant; some of them actually swim in humor, or sparkle with wit. These Mr. Froude faithfully prints, and perhaps relishes; but they do not seem to have any influence on his own gait or countenance in his office of biographer. This is unfortunate. No mind not profoundly in earnest itself could understand Carlyle, or represent him properly to others; but, if ever there was a life that required also some considerable amount of humor in the bystander for correct apprehension and interpretation of its singularities, it was Carlyle's. Those about him that knew him best, always felt that the most proper relation to much that he said and did was to take it humorously or suffuse it with humor; and that he himself had the same feeling and authorized it in others appeared in the frequency, almost the habitual constancy, with which he would check his conscious exaggerations at the last point with some ludicrous touch of self-irony, and would dissolve his fiercest objurgations and tumults of wrath in some sudden phantasy of the sheerly absurd and a burst of uproarious laughter. Without a recollection of this, many a saying of his, many a little incident of his daily life, is liable even now to misconstruction, or to interpretation out of its just proportions.

"Take for example Mr. Froude's story of Carlyle's behavior in the first days of his wife's severe illness in 1864, from the effects of a cab accident in the streets of London. 'The nerves and muscles,' says Mr. Froude, 'were completely disabled on the side on which she had fallen, and one effect was that the under-jaw had dropped and that she could not close it. Carlyle always disliked an open mouth; he thought it a sign of foolishness. One morning, when the pain was at its worst, he came into her room, and stood looking at her, leaning on the mantelpiece. 'Jane,' he said presently, 'ye had better shut your mouth.' She tried to tell him that she could not. 'Jane,' he began again, 'ye'll find yourself in a more compact and pious frame of mind if ye shut your mouth.' This story Mr. Froude received, he tells us, from Mrs. Carlyle herself; and there is no doubt as to its authenticity. What I am sure of is that Mr. Froude treats it too gravely, or might lead his readers to treat it too gravely, by missing that sense of the pure fun of the thing which was present in Mrs. Carlyle's mind when she remembered it afterward, however provoking it may have been at the moment.

"Insufficient appreciation of the amount of consciously humorous, and mutually admiring, give-and-take of this kind in the married life of the extraordinary pair, both of them so sensitively organized, has had much to do, it seems to me, with that elaborately studied contrast of them and too painful picture of their relations which Mr. Froude has succeeded in impressing upon the public. There were, it is true, passages of discord between them, of temporary jealousy and a sense of injury on one side at least, from causes too deep to be reached by this explanation; but it rubs away many a superficial roughness; and, if Mr. Froude had been more susceptible of humorous suggestions from his subject, he would not, I believe, have found this married life of Carlyle and Jane Welsh so exceptionally a tragedy throughout in comparison with other married lives, and would not have kept up such a uniform strain of dolefulness in his own performance of the part of the chorus. The immense seriousness of Carlyle's own mind and views of things, the apparent prevalence of the dark and dismal in his own action and monologue through the drama, even *required*, I should say, an unusual power of lightsomeness in the chorus, and this not as mere trick for literary relief, but actually for insight, correction, and compensation."

The lecture from which this passage is taken is full of acute insight into the personality of Carlyle, and is extremely interesting as a study in the interpretation of character; but the second lecture on "Carlyle's Literary Life and his Creed" will have such a special interest for the readers of the "Monthly" that we propose to make copious quotations from it.

Professor Masson begins by looking into the causes of the "belatedness" of Carlyle's literary life, or why it was so late before he achieved the success of world-wide recognition. He reminds us that Keats, Shelley, and Byron, who were contemporaries of Carlyle, had blazed into celebrity, finished their careers, and died, while Carlyle was yet an unknown man. Macaulay, who was by five years a younger man, had a brilliant national fame before Carlyle was recognized. "Not till 1837, when Carlyle was in his forty-second year, and had been three years resident in London—or, rather, not till between 1837 and 1840, when he was advancing from his forty-second year to his forty-fifth—did he burst fully upon the public. His 'History of the French Revolution,' published in 1837, began his popularity, not only evoking applauses for itself, but lifting up the unfortunate 'Sartor Resartus' into more friendly recognition." The "Miscellanies" and "Chartism" followed, and in 1840 appeared "Heroes and Hero-Worship," at which time we may assume that Carlyle had reached his full British celebrity.

Professor Masson speculates very suggestively over this phenomenon, calling attention to a profound change that gradually came over Carlyle's work, in which he passes from the superficial phase of *literature about literature* to the graver and deeper problems of human society and human action, and in which the mere *littérateur* is merged in the more serious philosopher.

"The causes of this 'belatedness' of Carlyle's literary life, to use an expression of Milton's, were various. There had, certainly, been no original defect or sluggishness of genius. The young Carlyle who had just completed his classes in Edinburgh University, the young Carlyle drudging at schoolmastering in Kirkcaldy, the young Carlyle of the next few years again walking in the streets of Edinburgh and living by private tutorship and hack-writing, was essentially the same Carlyle that became famous afterward—the same in moodiness, the same in moral magnanimity and integrity, the same in intellectual strength of grasp. One is astonished now by the uniformity of the testimonies of his intimates of those early days to his literary and other powers, the boundlessness of the terms in which they predicted his future distinction. His own early letters are also in the evidence. They are wonderful letters to have been written in the late teens and early twenties of a Scottish student's life, and paint him as even then a tremendous kind of person. As respects Carlyle's 'belatedness,' then, may not the fact that his element was to be *prose* and not *verse* count for something? It would seem as if that peculiar kind of poetic genius which tends to verse as its proper form of expression can always attain to mastery in that form with less of delay and discipline than is required for mastery in prose; and, at all events, the traditions of literature are such that the appearance of a new genius in verse is always more quickly hailed by the public than anything corresponding in prose. Now, much as Carlyle struggled after the faculty of metrical expression, ease in that faculty had evidently been denied him by Nature, and it was in prose or nothing that he was to manifest his superiority. Nay, in his earliest prose-writings for the press one observes something of the same stiffness, hard effort, and want of fluency that characterize almost all his verse-attempts. This, however, must have been in great part accidental; for we have only to go to some of his private letters, dashed off in his twentieth year or thereabout, to see that he had already acquired his marvelous power of picturesque and eloquent expression, and was master of a swift, firm, and musical style. But, for such a literary career as his was to be, mere gift of expression, however fluent and eloquent, was not enough. It was not enough that he should be able to write fluently and eloquently in a general way, by the exercise of mere natural talent, on any subject that turned up. He had to provide himself amply with *matter*, with systematized knowledge of all sorts, and especially with systematized historical knowledge. Hence the depth and extent of his readings, the range and perseverance of his studies in French, German, Italian, and Spanish, in addition to Latin and English. For writings so full-bodied as those he was to give to the world, it was necessary that he should step into literature as already himself a *polyhistor* or accomplished universal scholar; and, when he did step conspicuously into literature, it was in fact as already such a *polyhistor*.—In connection with which it is worth while to note how completely by that time Carlyle had emancipated himself from the common idea of so many of his literary contemporaries that literature ought to consist in writing about literature. To this day what are the chief subjects of the essays and books continually set forth by our professed authors? Why, the lives and writings of previous authors, the personages and phenomena of the past literary history of the world. We have Homer, Dante, Shakespeare, Milton, Goethe, and the other literary *dii majorum gentium*, over and over again, with descents to as many of the literary *dii minorum gentium* as may be necessary for variety; and the public is thus deluged with an eternal, ever-flowing literature merely about literature. Now, though Carlyle began in this way too—as witness his essays on Jean Paul Richter, on Goethe and *Faust*, on Burns, on German Playwrights, etc.—there were premonitions even then, both in his mode of handling these subjects and in the fact that such essays were interspersed with others of a more general and philosophic kind, that he would not dwell long in the element of mere literary history and æsthetic criticism, or be satisfied with adding his own contributions, however excellent, to the perpetual conversation about 'Shakespeare and the musical glasses.' Accordingly, before he had fully established himself, he had taken final leave of the mere literature about literature, and had moved on into a literature appertaining to human society and human action generally, to war and statesmanship, to poverty and crime, to the *quicquid agunt homines* in all lands and ages, literature as but one of the interests. As the capacity for this had to be included in his polyhistoric preparation, we have here also perhaps one of the causes of his comparative 'belatedness.' But there was another, and the chief of all. It lies in that fundamental characteristic of Carlyle's literary genius which Goethe had detected as early as 1827. 'It is admirable in Carlyle,' said Goethe to Eckermann in the July of that year, 'that in his judgments of our German authors he has especially in view the mental and moral core as that which is really influential. Carlyle is a *moral* force of great importance ; there is in him much for the future, and we can not foresee what he will produce and effect.' Goethe here struck the key-note. It was the depth and strength of the *moral* element in Carlyle's constitution that was to impart to his literary career its extraordinary importance and its special character of originality. Precisely on this account, however—precisely because he was to be no ordinary man of letters, turning out book after book as an artist turns out picture after picture, but a new moral force in the British community and the whole English-speaking community of the world—he had to bide his time. He had to ascertain and reason out his principles ; he had to form his creed. When he did burst fully upon the public it was to be not only as the polyhistor, not only as the humorist, not only as the splendid prose-artist, but also—to use a cant phrase which I do not like, though Carlyle himself rather favored it—as the Chelsea Prophet."

"But if Carlyle was slow in his own individual development, so that the success was long postponed, he must be regarded as slower, and still more 'belated,' with regard to the great progress of thought in this century. He belonged to a former age, and lived over into an age for which he was not prepared, and which he could not understand. He was an earnest man—a man, indeed, of great religious seriousness, and preached loyalty to truth as the supreme duty—but he was behind the age in knowing what truth is or how it is to be found. Of science he knew nothing, and could neither enter into its spirit nor employ its methods, nor even accept its great results. He had positive and systematic views which, although vague, he held with such great tenacity that he was disqualified from entering into those larger conceptions of Nature and the universe which pervade modern thought." On the creed and philosophy of Carlyle Professor Masson expatiates as follows :

"No need at this time of day to dilate on the literary merits of Carlyle's works. There they stand on our shelves, as extraordinary an array of volumes for combined solidity and splendor, all the product of one pen, as can be pointed to in the literature of English prose. It is with the *creed* running through the volumes that we are now concerned, that system of ideas by virtue of which Carlyle became, as Goethe predicted he would become, a powerful *moral* force in his generation, and on account of which his contemporaries styled him latterly the Chelsea Prophet.

"The first name affixed to Carlyle to signify a perception of the difference of his ways of thinking from those of other people was *Mystic.* This was the name given to him long ago in that Edinburgh circle round Jeffrey which he first stirred by his personal peculiarities when he was a resident in Comely Bank, and by his articles on German subjects. He seemed to be the apostle of an unknown something called 'German Mysticism,' and to be trying to found a school of 'English Mystics.' He dallied with the term himself for a while, and even took it with him to London. Intrinsically, however, there could have been no more absurd designation. By the whole cast of his intellect Carlyle was even the reverse of a mystic, constrained as he was always to definiteness of intellectual conception and to optical clearness of representation; and, though he had a kindly eye toward the Mystics, he could make nothing of them except by unmysticizing them—his essay on Novalis, for example, being an unsatisfactory attempt to extract gleams out of the opaque. It was the novelty of Carlyle's principles to those among whom they were first propounded, the strangeness of the objects he tried to bring within their ken, that occasioned the resort to such a misfitting epithet. A far fitter designation would have been *Transcendentalist.* Pardon me if I detain you a little with this word from the scholastic nomenclature and its applicability to Carlyle. It is easy enough to understand, and we have really no other name so suitable for the thing.

"A *Transcendentalist* in philosophy is the very opposite of what we call a *Secularist.* He is the opponent of that system of philosophy which "apprehends no further than this world and squares one's life according," that system of philosophy which regards the visible universe of time, space, and human experience as the sum total of all reality, and existing humanity in the midst of this universe as the topmost thing now in being. Beyond, and around, and even *in* this visible universe, the Transcendentalist holds—this world of sun, moon, and stars, and of the earth and human history in the midst—there is a supernatural world, a world of eternal and infinite mystery, invisible and inconceivable, yet most real, and so interconnected with the ongoings of the visible universe that constant reference to it is the supreme necessity of the human spirit, the highest duty of man, and the indispensable condition of all that is best in the human genius. In this sense Carlyle was a transcendentalist from the very first. He believed in a world of eternal and infinite realities *transcending* our finite world of time, space, sense, experience, and conceivability.

"In the scholastic nomenclature, however, there may be recognized two distinct varieties of Transcendentalism. There is, first, what may be called *Idealistic Transcendentalism* or *Transcendental Idealism.* By this idealistic theory all the apparent universe of known external realities—sun, moon, stars, rocks, clouds, earth, and human history and tradition—is resolved or reduced into mere present thinkings of your mind or my mind, a mere complex phantasmagory of the present human spirit; and therefore it is through this present human spirit that one has to seek the all-explaining bond of connection between the real world of finite nature and the real and infinite supernatural world. Now, though Carlyle was acquainted with this idealistic theory, had evident likings for it, and now and then favored it with a passing glance of exposition, I can not find that he had ever worked out the theory in all its bearings—an enormously difficult business—or adopted it intimately for his own behoof. He remained to the end what may be called a *Realistic Transcendentalist* or *Transcendental Realist.* By this is meant that he was satisfied to think of the world of space and time, and of all physical and historical realities, as having substantially existed, in its essential fabric at least, very much as we imagine it by an independent tenure from the Infinite, distinct from that of all past or present conceiving minds inserted into it and in traffic with it.

"Here, however, we may note an interesting peculiarity of his special form of Realistic Transcendentalism, which latterly gave him some trouble. Though he talks of 'rude nations,' 'rude times,' etc., and recognized perhaps a certain progress in human conditions and even in the human organism, he seems essentially to have always thought of humanity as a self-contained entity, fully fashioned within itself from the first, and cut off from all its material surroundings and from any priority of material beginnings. Hence his oppugnancy in his latter days to the modern scientific doctrine of evolution as brought into vogue more especially by the reasonings of Darwin. For a transcendentalist of the idealistic sort the doctrine of evolution can have no terrors. If the world of space, time, and history is but a fabrication of our present thinkings, a phantasmagory of the present human spirit, what does it matter how much our present thinkings may change, or how many æons of so-called time and imagined processes and marches of events we may find it necessary to throw into our phantasmagory? For the transcendental realist the difficulty is greater. Though he has the ultimate relief of believing that the entire procession or evolution of things physical as modern science would represent it—from the Universal Nebula on to the dispersed starry immensity, and so to the solar system, our earth as a planet in that system, and the history of that separate earth through the ages of its existence since it became separate—is but one vast forth-putting or manifestation of the inconceivable Absolute, he does not like to think of himself, the paragon of animals, or of the human mind and soul, as in any way really derived from this antecedent physical evolution, and more especially from those nearer portions of it which concern our separate earth and lead from protoplasmic slime, through differentiated bestialism, to a special ancestry in the ape. Some transcendental realists do get over the difficulty; but Carlyle never could. In June, 1868, he wrote in his journal as follows:

"'Surely the *speed* with which matters are going on in this supreme province of our affairs is something notable and sadly undeniable in late years. . . . "All descended from gorillas, seemingly." "Sun made by collision of huge masses of planets, asteroids, etc., in the infinite of space." Very possibly, say I. "Then where is the place for a Creator?" The *fool* hath said in his heart there is no God. From the beginning it has been so, is now, and to the end will be so. The *fool* hath said it—he and nobody else; and with dismal results in our days—as in all days; which often makes me sad to think of, coming nearer myself and the end of my life than I ever expected they would do. That of the sun, and his possibly being made in that manner, seemed to me a real triumph of science, indefinitely widening the horizon of our *theological* ideas withal, and awakened a good many thoughts in me when I first heard of it, and gradually perceived that there was actual scientific basis for it—I suppose the finest stroke that "Science," poor creature, has or may have succeeded in making during my time: welcome to me if it be a truth, honorably welcome! But what has it to do with the existence of the Eternal Unnamable?'

"The speculation as to the genesis of the sun and the probable duration of his heat here adverted to by Carlyle with such recognition of its real importance came before him first, I believe, in the form of a paper by Sir William Thomson, of Glasgow, which I had myself the honor of inserting in 'Macmillan's Magazine.' He was much struck with the paper at the time, and often mentioned it to me afterward. It is characteristic that he should have had less objection to this speculation, assigning a definite beginning to the whole solar system, and pointing perhaps to its ultimate collapse and the cessation of all terrestrial life, humanity included, with the extinction of the sun's heat, than to the nearer scientific speculation as to the evolution of species on the earth itself and man's descent from the gorilla. It is as if he found the imagination of a wholesale crash, whether of formation or of annihilation, in the far-back vast of physical immensity, or the far-future vast of the same, more cleanly, and therefore more endurable, than any imagination of a materialistic derivation of the human organism, through the ape and what not, from earthly protoplasmic slime. On the whole, one may say that he lived too late to be able to accept the modern scientific doctrine of evolution and work it into his philosophy, and remained therefore at the last a transcendental realist of the old school. Or perhaps, with the foregoing passage to enlighten us, it might be fairer to say that, whatever conceptions of a cosmic evolution science might bring in, he found them irrelevant to the main matter, and did not care a rush about them in comparison with the main matter—which was that men should continue to believe that all things had originated in a supreme and infinite eternal, the reality of all realities, and should walk in that belief as their religion.

"One may be a Transcendentalist in philosophy, however, whether of the Idealistic or of the Realistic sort, and yet go through the world calmly and composedly. Not so with Carlyle. Jeffrey's laughing complaint about him in the first days of their acquaintance was that he was always 'so dreadfully in earnest'; and no one can study the records of his early life without seeing what Jeffrey meant. Carlyle's vitality from his youth upward was something enormous. There was nothing sluggish or sleepy or cool in his constitution, and no capacity for being sluggish or sleepy or cool. He was always restlessly awake; to whatever subject he addressed himself, he grasped it, or coiled himself round it, as with muscles all on strain and nerves all a-tingling; and, when he had formed his conclusions, he was vehement in announcing them and aggressive in their propagation. Necessarily this was the case most of all with his conclusions on subjects the greatest and most fundamental. 'Woe to them that are at ease in Zion' was a text quite after his own heart, and which he was fond of applying to those who seemed to him to be sufficiently right in the main in their private ways of thinking on the deepest problems, but not to be sufficiently earnest in fighting for their conclusions and rousing and agitating society to get them accepted. Plato himself, the supreme transcendentalist of antiquity, and to this day unapproached among mankind for the magnificent sweep of clear intellect and the beauty and gorgeousness of poetic expression with which he expounded Transcendentalism once for all to the philosophic world, was in this category with Carlyle. 'He was a gentleman very much at ease in Zion' was Carlyle's definition of him. In fact, with the exception of Shakespeare in Elizabethan England and of Goethe in more recent times, the calm and composed type of character, in matters of sublime concern, was not that which won Carlyle's highest regard.

"Dropping now all terms of scholastic nomenclature, we may say, more simply, that Carlyle went through the world as a fervid Theist. God, the Almighty, the Maker of all—through all the eighty-five years of Carlyle's life, all the seventy of his speech and writing, this was his constant phrase to his fellow-mortals. 'There *is* a God, there *is* a God, there *is* a God'—not even did the Koran of Mohammed fulminate this message more incessantly in the ears, or burn it more glowingly into the hearts, of the previously atheistic Arabs whom the inspired camel-driver sought to rouse, than did the series of Carlyle's writings fulminate it and try to make it blaze in a region and generation where, as he imagined, despite all the contrary appearances of organized churches and myriads of clergy and of pulpits, the canker of atheism was again all but universal. When he avoided the simple name 'God' or 'the Almighty,' and had recourse to those phrases—'the Immensities,' 'the Eternities,' 'the Silences,' 'the Infinite Unnamable'—which we now think of, perhaps smilingly, as peculiar forms of the Carlylian rhetoric, it was, as he himself tells us, because 'the old Numen' had become as if obsolete to 'the huge idly impious million of writing, preaching, and talking people,' and he would employ any synonyms or verbal shifts by which he could hope to bring back the essential notion. In his latter days, and always in his own pious self-communings, he seems to have preferred the simple old name he had learned from his father and mother, with its heart-thrilling and heart-softening associations."

Professor Masson then enters upon the question of Carlyle's relation to Christianity, which is too fully treated for insertion here. The curious reader is referred to the discussion itself, which is remarkably interesting. Professor Masson distinguishes between the *Ethic*, or the moral code of Christianity, and its *Metaphysic*, or body of supernaturally derived beliefs. Carlyle accepted the former, but rejected the latter, which, Professor Masson argues, is after all the essential and distinguishing attribute of Christianity. On this point he thus reasons:

"The *ethic* without this *metaphysic* may call itself Christianity, but is not, I hold, Christianity in any sense worth so special a name. To tell men, however earnestly, not to tell lies, not to commit fraud, to be temperate, honest, truthful, merciful, even to be humble, pious, and God-fearing, is very good gospel; but it did not require the events of Judea, as Christian theology interprets them, to bring *that* gospel into the world. The modern preacher who sermonizes always on the ethic and omits the accompanying metaphysic may sophisticate himself into a belief that he is preaching Christianity, but is preaching no such thing. Wherever Christianity has been of real effect in the world, and has made real way for its own ethic, it has been by its metaphysic—that set of doctrines respecting things supernatural which was to the Jews a stumbling-block and to the Greeks foolishness. Now, as Carlyle had wholly given up the metaphysic of Christianity, he can not be classed among the Christians, and thought it honest to avow that he could not be so classed. Indeed, more and more, his attitude toward Christian theology in any of its known and orthodox forms settled into positive antipathy, till at last he declared it to be inconceivable to him that any man of real intellect could be found in that camp without something of conscious insincerity, and looked askance, therefore, on even such ecclesiastical friends of his own as Bishop Thirlwall and Bishop Wilberforce. This feeling found vent in such violent phrases as *shovel-hattedness*, *the Jew-God*, etc.; and he had even been so daring as to project a book or pamphlet to be called 'Exodus from Houndsditch,' the purport of which was to be that people ought universally, as fast as they could, to come out of the land and atmosphere of all Jewish forms and traditions, older or later, only taking care to pack up what was really their own and bring *that* along with them."

The scientific deficiency of Carlyle's mind was nowhere displayed more strikingly than in his scornful rejection of what science has accomplished in the very fields which he himself cultivated—i. e., the phenomena of human and social affairs. Political economy, as is well known, was his abomination. He is forever talking of "facts," but forever deriding those who studied them methodically. On this point, Professor Masson observes :

"What was even worse, Carlyle not only refused the trouble of considerations of the merely mechanical kind himself, but regarded too generally with contempt the labors and speculations of others in that region. His impatience of reasoned political science in any form, and especially in the form of that modern political economy which he derided as 'the dismal science,' really shut him out, more than he was himself aware, from that intimacy with the 'fact of things' which he defined so energetically as the all-essential necessity for men of all sorts and the sole attainable wisdom. It is by science only, by reasoned investigation only, that we can know, in any department, what *is* the real 'fact of things' ; and till we know, from the teachings of strict political science, whether in its present form of so-called political economy, or in some larger and better form, all that we can know of the real 'fact of things' in that department, our practical efforts in politics and philanthropy will continue to be, as they have too much been heretofore, mere knocking of our heads against stone walls, mere pourings of water into sieves. Not less in all matters and contemplations, physical and cosmological, must we receive our instructions as to the real 'fact of things' from the sciences thereto appertaining. If science tells us surely and conclusively that such and such was and has been the course of actual physical nature, then we are bound, whether we like it or not, to imagine the past physical course of things precisely in that manner ; and, if we persist in imagining it one whit otherwise, we incur the guilt of opposing the light, and are untrue to the 'fact of things.' Carlyle, as we have seen, acknowledged this ; but it was but a passing acknowledgment. He was too old, his inveteracy in the constitutional faiths of his own spirit was too confirmed, to permit him to adjust these faiths to the new cosmological conceptions which science was making imperative in his later days, or even to perceive that it was of any great consequence that this should be done."

RELATIONS OF SCIENCE TO THE PUBLIC WEAL.*

By Sir LYON PLAYFAIR, K. C. B., M. P., F. R. S.

PART SECOND.

V. SCIENCE AND INDUSTRY.—In the popular mind the value of science is measured by its applications to the useful purposes of life. It is no doubt true that science wears a beautiful aspect when she confers practical benefits upon man. But truer relations of science to industry are implied in Greek mythology. Vulcan, the god of industry, wooed science, in the form of Minerva, with a passionate love, but the chaste goddess never married, although she conferred upon mankind nearly as many arts as Prometheus, who, like other inventors, saw civilization progressing by their use while he lay groaning in want on Mount Caucasus. The rapid development of industry in modern days depends on the applications of scientific knowledge, while its slower growth in former times was due to experiments being made by trial and error in order to gratify the needs of man. Then an experiment was less a questioning of Nature than an exercise on the mind of the experimentalist. For a true questioning of Nature only arises when intellectual conceptions of the causes of phenomena attach themselves to ascertained facts as well as to their natural environments. Much real science had at one time accumulated in Egypt, Greece, Rome, and Arabia, though it became obscured by the intellectual darkness which spread over Europe like a pall for many centuries. The mental results of Greek science, filtered through the Romans and Arabians, gradually fertilized the soil of Europe. Even in ages which are deemed to be dark and unprolific, substantial though slow progress was made. By the end of the fifteenth century the mathematics of the Alexandrian school had become the possession of Western Europe; Arabic numerals, algebra, trigonometry, decimal reckoning, and an improved calendar, having been added to its stock of knowledge. The old discoveries of Democritus and Archimedes in physics, and of Hipparchus and Ptolemy in astronomy, were producing their natural developments, though with great slowness. Many manufactures, growing chiefly by experience, and occasionally lightened up by glimmerings of science throughout the prevailing darkness, had arisen before the sixteenth century. A knowledge of the properties of bodies, though scarcely of their relations to each other, came through the labors of the alchemists, who had a mighty impulse to work, for by the philosopher's stone, often not larger than half a rape-

* Inaugural address of the President of the British Association for the Advancement of Science, at the Aberdeen meeting, September 9, 1885.

seed, they hoped to attain the three sensuous conditions of human enjoyment, gold, health, and immortality. By the end of the fifteenth century many important manufactures were founded by empirical experiment, with only the uncertain guidance of science. Among these were the compass, printing, paper, gunpowder, guns, watches, forks, knitting-needles, horseshoes, bells, wood-cutting and copper-engraving, wire-drawing, steel, table-glass, spectacles, microscopes, glass mirrors backed by amalgams of tin and lead, windmills, crushing and saw mills. These important manufactures arose from an increased knowledge of facts, around which scientific conceptions were slowly concreting. Aristotle defines this as science when he says, "Art begins when, from a great number of experiences, one general conception is formed which will embrace all similar cases." Such conceptions are formed only when culture develops the human mind and compels it to give a rational account of the world in which man lives, and of the objects in and around it, as well as of the phenomena which govern their action and evolution. Though the accumulation of facts is indispensable to the growth of science, a thousand facts are of less value to human progress than is a single one when it is scientifically comprehended, for it then becomes generalized in all similar cases. Isolated facts may be viewed as the dust of science. The dust which floats in the atmosphere is to the common observer mere incoherent matter in a wrong place, while to the man of science it is all-important when the rays of heat and light act upon its floating particles. It is by them that clouds and rains are influenced; it is by their selective influence on the solar waves that the blue of the heavens and the beauteous colors of the sky glorify all Nature. So, also, ascertained though isolated facts, forming the dust of science, become the reflecting media of the light of knowledge, and cause all Nature to assume a new aspect. It is with the light of knowledge that we are enabled to question Nature through direct experiment. The hypothesis or theory which induces us to put the experimental question may be right or wrong; still, *prudens questio dimidium scientiæ est*—it is half-way to knowledge when you know what you have to inquire. Davy described hypothesis as the mere scaffolding of science, useful to build up true knowledge, but capable of being put up or taken down at pleasure. Undoubtedly a theory is only temporary, and the reason is, as Bacon has said, that the man of science "loveth truth more than his theory." The changing theories which the world despises are the leaves of the tree of science drawing nutriment to the parent stems, and enabling it to put forth new branches and to produce fruit; and, though the leaves fall and decay, the very products of decay nourish the roots of the tree and reappear in the new leaves or theories which succeed.

When the questioning of Nature by intelligent experiment has raised a system of science, then those men who desire to apply it to industrial inventions proceed by the same methods to make rapid progress in the arts. They also must have means to compel Nature to reveal her secrets. Æneas succeeded in his great enterprise by plucking a golden branch from the tree of science. Armed with this even dread Charon dared not refuse a passage across the Styx; and the gate of the Elysian fields was unbarred when he hung the branch on its portal. Then new aspects of Nature were revealed:

> "Another sun and stars they know
> That shine like ours, but shine below."

It is by carrying such a golden branch from the tree of science that inventors are able to advance the arts. In illustration of how slowly at first and how rapidly afterward science and its applications arise, I will take only two out of thousands of examples which lie ready to my hand. One of the most familiar instances is air, for that surely should have been soon understood if man's unaided senses are sufficient for knowledge. Air has been under the notice of mankind ever since the first man drew his first breath. It meets him at every turn; it fans him with gentle breezes, and it buffets him with storms. And yet it is certain that this familiar object—air—is very imperfectly understood up to the present time. We now know by recent researches that air can be liquefied by pressure and cold; but as a child still looks upon air as nothing, so did man in his early state. A vessel filled with air was deemed to be empty. But man, as soon as he began to speculate, felt the importance of air, and deemed it to be a soul of the world upon which the respiration of man and the godlike quality of fire depended. Yet a really intelligent conception of these two essential conditions to man's existence, respiration and combustion, was not formed till about a century ago (1775). No doubt long before that time there had been abundant speculations regarding air. Anaximenes, five hundred and forty-eight years before Christ, and Diogenes of Apollonia, a century later, studied the properties of air so far as their senses would allow them; so, in fact, did Aristotle. Actual scientific experiments were made on air about the year 1100 by a remarkable Saracen, Alhazen, who ascertained important truths which enabled Galileo, Torricelli, Otto de Guericke, and others at a later period, to discover laws leading to important practical applications. Still there was no intelligent conception as to the composition of air until Priestley in 1774 repeated, with the light of science, an empirical observation which Eck de Sulbach had made three hundred years before upon the union of mercury with an ingredient of air, and the decomposition of this compound by heat. This experiment now proved that the active element in air is oxygen. From that date our knowledge, derived from an intelligent questioning of air by direct experiments, has gone on by leaps and bounds. The air, which mainly consists of nitrogen and oxygen, is now known to contain carbonic acid, ammonia, nitric acid, ozone, besides hosts of living organisms which have a vast influence for good or evil in the economy of the world. These micro-organisms, the latest contribution to our knowledge of air, perform great analytical functions in organic nature, and are the means of converting much of its potential energy into actual energy. Through their action on dead matter the mutual dependence of plants and animals is secured, so that the air becomes at once the grave of organic death and the cradle of organic life. No doubt the ancients suspected this without being able to prove the dependence. Euripides seems to have seen it deductively when he describes the results of decay :

> "Then that which springs from earth, to earth returns,
> And that which draws its being from the sky
> Rises again up to the skyey height."

The consequences of the progressive discoveries have added largely to our knowledge of life, and have given a marvelous development to the industrial arts. Combustion and respiration govern a wide range of processes. The economical use of fuel, the growth of plants, the food of animals, the processes of husbandry, the maintenance of public health, the origin and cure of disease, the production of alcoholic drinks, the processes of making vinegar and saltpeter—all these and many other kinds of knowledge have been brought under the dominion of law. No doubt animals respired, fuel burned, plants grew, sugar fermented, before we knew how they depended upon air. But, as the knowledge was empirical, it could not be intelligently directed. Now all these processes are ranged in order under a wise economy of Nature, and can be directed to the utilities of life : for it is true, as Swedenborg says, that human "ends always ascend as Nature descends." There is scarcely a large industry in the world which has not received a mighty impulse by the better knowledge of air acquired within a hundred years. If I had time I could show still more strikingly the industrial advantages which have followed from Cavendish's discovery of the composition of water. I wish that I could have done this, because it was Addison who foolishly said, and Paley who as unwisely approved the remark, that "mankind required to know no more about water than the temperature at which it froze and boiled, and the mode of making steam."

When we examine the order of progress in the arts, even before they are illumined by science, their improvements seem to be the resultants of three conditions :

1. The substitution of natural forces for brute animal power, as when Hercules used the waters of the Alpheus to cleanse the Augean stables ; or when a Kamchadal of Eastern Asia, who has been three years hollowing out a canoe, finds that he can do it in a few hours by fire.

2. The economy of time, as when a calendering machine produces the same gloss to miles of calico that an African savage gives to a

few inches by rubbing it with the shell of a snail; or the economy of production, as when steel pens, sold when first introduced at one shilling apiece, are now sold at a penny per dozen; or when steel rails, lately costing forty-five pounds per ton, can now be sold at five pounds.

3. Methods of utilizing waste products, or of endowing them with properties which render them of increased value to industry, as when waste scrap-iron and the galls on the oak are converted into ink; or the badly-smelling waste of gas-works is transformed into fragrant essences, brilliant dyes, and fertilizing manure; or when the effete matter of animals or old bones is changed into lucifer-matches.

All three results are often combined when a single end is obtained; at all events, economy of time and production invariably follows when natural forces substitute brute animal force. In industrial progress the sweat of the brow is lessened by the conceptions of the brain. How exultant is the old Greek poet, Antipater,* when women are relieved of the drudgery of turning the grindstones for the daily supply of corn! "Woman! you who have hitherto had to grind corn, let your arms rest for the future. It is no longer for you that the birds announce by their songs the dawn of the morning. Ceres has ordered the *water-nymphs* to move the heavy millstones and perform your labor." Penelope had twelve slaves to grind corn for her small household. During the most prosperous time of Athens it was estimated that there were twenty slaves to each free citizen. Slaves are mere machines, and machines neither invent nor discover. The bondmen of the Jews, the helots of Sparta, the captive slaves of Rome, the serfs of Europe, and uneducated laborers of the present day who are the slaves of ignorance, have added nothing to human progress. But, as natural forces substitute and become cheaper than slave-labor, liberty follows advancing civilization. Machines require educated superintendence. One shoe-factory in Boston by its machines does the work of thirty thousand shoemakers in Paris, who have still to go through the weary drudgery of mechanical labor. The steam-power of the world during the last twenty years has risen from eleven and a half million to twenty-nine million horse-power, or one hundred and fifty-two per cent.

Let me take a single example of how even a petty manufacture improved by the teachings of science affects the comforts and enlarges the resources of mankind. When I was a boy the only way of obtaining a light was by the tinder-box with its quadruple materials, flint and steel, burned rags or tinder, and a sulphur-match. If everything went well, if the box could be found and the air was dry, a light could be obtained in two minutes; but very often the time occupied was much longer, and the process became a great trial to the serenity of temper. The consequence of this was, that a fire or a burning lamp was kept alight through the day. Old Gerard, in his "Herbal," tells

* "Analecta Veterum Græcorum," Epig. 39, vol. ii, p. 119.

us how certain fungi were used to carry fire from one part of the country to the other. The tinder-box long held its position as a great discovery in the arts. The *pyxidicula igniaria* of the Romans appears to have been much the same implement, though a little ruder than the flint and steel which Philip the Good put into the collar of the Golden Fleece in 1429 as a representation of high knowledge in the progress of the arts. It continued to prevail till 1833, when phosphorus-matches were introduced, though I have been amused to find that there are a few venerable ancients in London who still stick to the tinder-box, and for whom a few shops keep a small supply. Phosphorus was no new discovery, for it had been obtained by an Arabian called Bechel in the eighth century. However, it was forgotten, and was rediscovered by Brandt, who made it out of very stinking materials in 1669. Other discoveries had, however, to be made before it could be used for lucifer-matches. The science of combustion was only developed on the discovery of oxygen a century later. Time had to elapse before chemical analysis showed the kind of bodies which could be added to phosphorus so as to make it ignite readily. So it was not till 1833 that matches became a partial success. Intolerably bad they then were, dangerously inflammable, horribly poisonous to the makers, and injurious to the lungs of the consumers. It required another discovery by Schrötter, in 1845, to change poisonous waxy into innocuous red-brick phosphorus in order that these defects might be remedied and to give us the safety-match of the present day. Now, what have these successive discoveries in science done for the nation, in this single manufacture, by an economy of time? If before 1833 we had made the same demands for light that we now do, when we daily consume eight matches per head of the population, the tinder-box could have supplied the demand under the most favorable conditions by an expenditure of one quarter of an hour. The lucifer-match supplies a light in fifteen seconds on each occasion, or in two minutes for the whole day. Putting these differences into a year, the venerable ancient who still sticks to his tinder-box would require to spend ninety hours yearly in the production of light, while the user of lucifer-matches spends twelve hours, so that the latter has an economy of seventy-eight hours yearly, or about ten working days. Measured by cost of production at one shilling and sixpence daily, the economy of time represented in money to our population is twenty-six millions of pounds annually. This is a curious instance of the manner in which science leads to economy of time and wealth even in a small manufacture. In larger industries the economy of time and labor produced by the application of scientific discoveries is beyond all measurement. Thus the discovery of latent heat by Black led to the inventions of Watt, while that of the mechanical equivalent of heat by Joule has been the basis of the progressive improvements in the steam-engine which enables power to be obtained by a consumption of fuel less than one fourth the amount used twenty years ago. It may be that the engines of Watt and Stephenson will yield in their turn to more economical motors; still, they have already expanded the wealth, resources, and even the territories of England, more than all the battles fought by her soldiers or all the treaties negotiated by her diplomatists.

The coal which has hitherto been the chief source of power probably represents the product of five or six million years during which the sun shone upon the plants of the carboniferous period, and stored up its energy in this convenient form. But we are using this conserved force wastefully and prodigally, for, although horse-power in steam-engines has so largely increased since 1864, two men only now produce what three men did at that date. It is only three hundred years since we became a manufacturing country. According to Professor Dewar, in less than two hundred years more the coal of this country will be wholly exhausted, and in half that time will be difficult to procure. Our not very distant descendants will have to face the problem, What will be the condition of England without coal? The answer to that question depends upon the intellectual development of the nation at that time. The value of the intellectual factor of production is continually increasing, while the values of raw material and fuel are lessening factors. It may be that, when the dreaded time of exhausted fuel has arrived, its importation from other coal-fields, such as those of New South Wales, will be so easy and cheap that the increased technical education of our operatives may largely overbalance the disadvantages of increased cost in fuel; but this supposes that future governments in England will have more enlightened views as to the value of science than past governments have possessed.

Industrial applications are but the overflowings of science welling over from the fullness of its measure. Few would ask now, as was constantly done a few years ago, "What is the use of an abstract discovery in science?" Faraday once answered this question by another, "What is the use of a baby?" Yet round that baby center all the hopes and sentiments of its parents, and even the interests of the state, which interferes in its upbringing so as to insure it being a capable citizen. The processes of mind which produce a discovery or an invention are rarely associated in the same person, for, while the discoverer seeks to explain causes and the relations of phenomena, the inventor aims at producing new effects, or at least of obtaining them in a novel and efficient way. In this the inventor may sometimes succeed without much knowledge of science, though his labors are infinitely more productive when he understands the causes of the effects which he desires to produce.

A nation in its industrial progress, when the competition of the world is keen, can not stand still. Three conditions only are possible for it. It may go forward, retrograde, or perish. Its extinction as a great nation follows its neglect of higher education, for, as described in the proverb of Solomon, "They that hate instruction love death." In sociology, as in biology, there are three states. The first of balance, when things grow neither better nor worse; the second that of elaboration or evolution, as we see it when animals adapt themselves to their environments; and third, that of degeneration, when they rapidly lose the ground they have made. For a nation, a state of balance is only possible in the early stage of its existence, but it is impossible when its environments are constantly changing.

The possession of the raw materials of industry and the existence of a surplus population are important factors for the growth of manufactures in the early history of a nation, but afterward they are bound up with another factor—the application of intellect to their development. England could not be called a manufacturing nation till the Elizabethan age. No doubt coal, iron, and wood were in abundance, though, in the reign of the Plantagenets, they produced little prosperity. Wool was sent to Flanders to be manufactured, for England then stood to Holland as Australia now does to Yorkshire. The political crimes of Spain, from the reign of Ferdinand and Isabella to that of Philip III, destroyed it as a great manufacturing nation, and indirectly led to England taking its position. Spain, through the activity and science of the Arabian intellect, had acquired many important industries. The Moors and the Moriscoes, who had been in Spain for a period as long as from the Norman conquest of this country to the present date, were banished, and with them departed the intellect of Spain. Then the invasion of the Low Countries by Philip II drove the Flemish manufacturers to England, while the French persecution of the Huguenots added new manufacturing experience, and with them came the industries of cotton, wool, and silk. Cotton mixed with linen and wool became freely used, but it was only from 1738 to the end of the century that the inventions of Wyatt, Arkwright, Hargreaves, Compton, and Cartwright started the wonderful modern development. The raw cotton was imported from India or America, but that fact as regards cost was a small factor in comparison with the intellect required to convert it into a utility. Science has in the last hundred years altered altogether the old conditions of industrial competition. She has taught the rigid metals to convey and record our thoughts even to the most distant lands, and, within less limits, to reproduce our speech. This marvelous application of electricity has diminished the cares and responsibilities of governments, while it has at the same time altered the whole practice of commerce. To England steam and electricity have been of incalculable advantage. The ocean, which once made the country insular and isolated, is now the very life-blood of England and of the greater England beyond the seas. As in the human body the blood bathes all its parts, and through its traveling corpuscles carries force to all its members, so in the body politic of England and its pelasgic extensions steam has become the circulatory and electricity the nervous system. The colonies, being young countries, value their raw materials as their chief sources of wealth. When they become older they will discover it is not on these, but on the culture of scientific intellect, that their future prosperity depends. Older nations recognize this as the law of progress more than we do; or, as Jules Simon tersely puts it, "That nation which most educates her people will become the greatest nation, if not to-day, certainly to-morrow." Higher education is the condition of higher prosperity, and the nation which neglects to develop the intellectual factor of production must degenerate, for it can not stand still. If we felt compelled to adopt the test of science given by Comte, that its value must be measured by fecundity, it might be prudent to claim industrial inventions as the immediate fruit of the tree of science, though only fruit which the prolific tree has shed. But the test is untrue in the sense indicated, or rather the fruit, according to the simile of Bacon, is like the golden apples which Aphrodite gave to the suitor of Atalanta, who lagged in his course by stooping to pick them up, and so lost the race. The true cultivators of the tree of science must seek their own reward by seeing it flourish, and let others devote their attention to the possible practical advantages which may result from their labors.

There is, however, one intimate connection between science and industry which I hope will be more intimate as scientific education becomes more prevalent in our schools and universities. Abstract science depends upon the support of men of leisure, either themselves possessing or having provided for them the means of living without entering into the pursuits of active industry. The pursuit of science requires a superfluity of wealth in a community beyond the needs of ordinary life. Such superfluity is also necessary for art, though a picture or a statue is a salable commodity, while an abstract discovery in science has no immediate or, as regards the discoverer, proximate commercial value. In Greece, when philosophical and scientific speculation was at its highest point, and when education was conducted in its own vernacular and not through dead languages, science, industry, and commerce were actively prosperous. Corinth carried on the manufactures of Birmingham and Sheffield, while Athens combined those of Leeds, Staffordshire, and London, for it had woolen manufactures, potteries, gold and silver work, as well as ship-building. Their philosophers were the sons of burghers, and sometimes carried on the trades of their fathers. Thales was a traveling oil-merchant, who brought back science as well as oil from Egypt. Solon and his great descendant, Plato, as well as Zeno, were men of commerce. Socrates was a stone-mason; Thucydides a gold-miner; Aristotle kept a druggist's shop until Alexander endowed him with the wealth of Asia. All but Socrates had a superfluity of wealth, and he was supported by that of others. Now, if our universities and schools created that love of science which a broad education would surely inspire, our men of riches and leisure who advance the boundaries of scientific knowledge could not be counted on the fingers as they now are, when we think of Boyle, Cavendish, Napier, Lyell, Murchison, and Darwin, but would be as numerous as our statesmen and orators. Statesmen, without a following of the people who share their views and back their work, would be feeble indeed. But, while England has never lacked leaders in science, they have too few followers to risk a rapid march. We might create an army to support our generals in science, as Germany has done, and as France is now doing, if education in this country would only mold itself to the needs of a scientific age. It is with this feeling that Horace Mann wrote: "The action of the mind is like the action of fire: one billet of wood will hardly burn alone, though as dry as the sun and northwest wind can make it, and though placed in a current of air; ten such billets will burn well together, but a hundred will create a heat fifty times as intense as ten —will make a current of air to fan their own flame, and consume even greenness itself."

VI. Abstract Science the Condition for Progress.—The subject of my address has been the relations of science to the public weal. That is a very old subject to select for the year 1885. I began it by quoting the words of an illustrious prince, the consort of our Queen, who addressed us on the same subject from this platform twenty-six years ago. But he was not the first prince who saw how closely science is bound up with the welfare of states. Ali, the son-in-law of Mohammed, the fourth successor to the caliphate, urged upon his followers that men of science and their disciples give security to human progress. Ali loved to say, "Eminence in science is the highest of honors," and "He dies not who gives life to learning." In addressing you upon texts such as these, my purpose was to show how unwise it is for England to lag in the onward march of science when most other European powers are using the resources of their states to promote higher education and to advance the boundaries of knowledge. English Governments alone fail to grasp the fact that the competition of the world has become a competition in intellect. Much of this indifference is due to our systems of education. I have ill fulfilled my purpose if, in claiming for science a larger share in public education, I have in any way depreciated literature, art, or philosophy, for every subject which adds to culture aids in human development. I only contend that in public education there should be a free play to the scientific faculty, so that the youths who possess it should learn the richness of their possession during the educative process. The same faculties which make a man great in any walk of life—strong love of truth, high imagination tempered by judgment, a vivid memory which can co-ordinate other facts with those under immediate consideration —all these are qualities which the poet, the philosopher, the man of literature, and the man of science equally require, and should cultivate through all parts of their education as well as in their future careers. My contention is that science should not be practically shut out from the view of a youth while his education is in progress, for the public weal requires that a large number of scientific men should belong to the community. This is necessary because science has impressed its character upon the age in which we live, and, as science is not stationary but progressive, men are required to advance its boundaries, acting as pioneers in the onward march of states. Human progress is so identified with scientific thought, both in its conception and realization, that it seems as if they were alternative terms in the history of civilization. In literature, and even in art, a standard of excellence has been attained which we are content to imitate because we have been unable to surpass. But there is no such standard in science. Formerly, when the dark cloud was being dissipated which had obscured the learning of Greece and Rome, the diffusion of literature or the discovery of lost authors had a marked influence on advancing civilization. Now, a Chrysoloras might teach Greek in the Italian universities without hastening sensibly the onward march of Italy ; a Poggio might discover copies of Lucretius and Quintilian without exercising a tithe of the influence on modern life that an invention by Stephenson or Wheatstone would produce. Nevertheless, the divorce of culture and science, which the present state of education in this country tends to produce, is deeply to be deplored, because a cultured intelligence adds greatly to the development of the scientific faculty. My argument is that no amount of learning without science suffices in the present state of the world to put us in a position which will enable England to keep ahead of, or even on a level with foreign nations as regards knowledge and its applications to the utilities of life. Take the example of any man of learning, and see how soon the direct consequences resulting from it disappear in the life of a nation, while the discoveries of a man of science remain productive amid all the shocks of empire. As I am in Aberdeen, I remember that the learned Dutchman Erasmus was introduced to England by the encouragement which he received from Hector Boece, the Principal of King's College in this university. Yet even in the case of Erasmus—who taught Greek at Cambridge, and did so much for the revival of classical literature as well as in the promotion of spiritual freedom—how little has civilization to ascribe to him in comparison with the discoveries of two other Cambridge men, Newton and Cavendish ! The discoveries of Newton will influence the destinies of mankind to the end of the world. When he established the laws by which the motions of the great masses of matter in the universe are governed, he conferred an incalculable benefit upon the intellectual development of the human race. No great discovery flashes upon the world at once, and therefore Pope's lines on Newton are only a poetic fancy :

> "Nature and Nature's laws lay hid in night;
> God said, 'Let Newton be,' and all was light."

No doubt the road upon which he traveled had been long in preparation by other men. The exact observations of Tycho Brahe, coupled with the discoveries of Copernicus, Kepler, and Galileo, had already broken down the authority of Aristotle and weakened that of the Church. But, though the conceptions of the universe were thus broadened, mankind had not yet rid themselves of the idea that the powers of the universe were still regulated by spirits or special providences. Even Kepler moved the planets by spirits, and it took some time to knock these celestial steersmen on the head. Descartes, who really did so much by his writings to force the conclusion that the planetary movements should be dealt with as an ordinary problem in mechanics, looked upon the universe as a machine, the wheels of which were kept in motion by the unceasing exercise of a divine power. Yet such theories were only an attempt to regulate the universe by celestial intelligences like our own, and by standards within our reach. It required the discovery of an all-pervading law, universal throughout all space, to enlarge the thoughts of men, and one which, while it widened the conceptions of the universe, reduced the earth and solar system to true dimensions. It is by the investigation of the finite on all sides that we obtain a higher conception of the infinite:

> "Willst du ins Unendliche schreiten,
> Geh nur im Endlichen nach allen Seiten."

Ecclesiastical authority had been already undermined by earnest inquirers such as Wycliffe and Huss before Luther shook the pillars of the Vatican. They were removers of abuses, but were confined within the circles of their own beliefs. Newton's discovery cast men's minds into an entirely new mold, and leveled many barriers to human progress. This intellectual result was vastly more important than the practical advantages of the discovery. It is true that navigation and commerce mightily benefited by our better knowledge of the motions of the heavenly bodies. Still, these benefits to humanity are incomparably less in the history of progress than the expansion of the human intellect which followed the withdrawal of the cramps that confined it. Truth was now able to discard authority, and marched forward without hindrance. Before this point was reached, Bruno had been burned, Galileo had abjured, and both Copernicus and Descartes had kept back their writings for fear of offending the Church.

The recent acceptance of evolution in biology has had a like effect in producing a far profounder intellectual change in human thought than any mere impulse of industrial development. Already its application to sociology and education is recognized, but that is of less import to human progress than the broadening of our views of Nature.

Abstract discovery in science is then the true foundation upon which the superstructure of modern civilization is built; and the man who would take part in it should study science, and, if he can, advance it for its own sake and not for its applications. Ignorance may walk in the path lighted by advancing knowledge, but she is unable to follow when science passes her, for, like the foolish virgin, she has no oil in her lamp.

An established truth in science is like the constitution of an atom in matter—something so fixed in the order of things that it has become independent of further dangers in the struggle for existence. The sum of such truths forms the intellectual treasure which descends to each generation in hereditary succession. Though the discoverer of a new truth is a benefactor to humanity, he can give little to futurity in comparison with the wealth of knowledge which he inherited from the past. We, in our generation, should appreciate and use our great possessions:

"For me your tributary stores combine,
Creation's heir; the world, the world is mine."

[*Concluded.*]

THE UNIFORMITY OF NATURE.

BY THE BISHOP OF CARLISLE.

THE chief interest felt by readers of the reminiscence of a meeting of the Metaphysical Society, contained in the August number of this review, will probably be found in the striking and really remarkable record of the discussion of a difficult subject by such men as we there find, and under such conditions as are there described. Whatever the subject of discussion, such a symposium so felicitously saved from oblivion could not fail to secure attention and much gratitude to the able chiel who took notes and printed it. But in truth the subject discussed is as interesting as the company who discussed it; and to the writer of the present paper has so proved itself, not only on general grounds, but also because the view which seems to him to be chiefly worthy of consideration, as being the most true and the most luminous, does not appear to have presented itself to the mind of any one of the speakers, or at all events not to have been expressed clearly.

The discussion, as reported, labors under the great defect that there was no preliminary attempt to define the meaning of the phrase which formed the subject of the argument. Yet the "unformity of Nature" is an expression which does not carry upon its front one clear meaning, and one clear meaning only, and therefore needs definition if the truth of any proposition supposed to be implied by it is either to be affirmed or to be denied. In some senses Nature is obviously not uniform. Take the case of the weather: what can have less of the character of uniformity? Take the seasons: and observe the apparently absolute absence of all rule as to the sequence of fruitful and unfruitful years. Take almost any instance of natural phenomena that you please: and the variety, the eccentricity, the lawlessness, will probably be quite as striking as any characteristic which can be described by the word uniformity. Anyhow, in commencing a discussion, we ought to know precisely what the phrase to be discussed means, or at least what it is held to mean by the disputants engaged in the argument.

I observe that one of the interlocutors of the Metaphysical Society, Mr. Walter Bagehot, affirms that experience can not prove the uniformity of Nature, because it is impossible to say what the uniformity of Nature means. If this be so, and I am not just now contradicting the assertion, all serious discussion must be at an end. It is very well to say that, although experience can never prove the absolute uniformity of Nature, it ought to "train us to bring our expectations into something like consistency with the uniformity of Nature." But why should we expect Nature to be uniform, unless we can give some good reason for believing in this uniformity? And why should we trouble ourselves with a principle of uniformity, the meaning of which, by hypothesis, we are unable to assign?

On the other hand, Mr. Ruskin could scarcely hope to carry many of the company with him when he avowed his disbelief in uniformity altogether, and affirmed that if told that the sun had stood still he would reply: "A miracle that the sun stands still? Not at all—I always expected it would." This view of the matter would seem to imply that there is no principle in Nature which can in any way be described as law or uniformity—a conclusion which is opposed to all our knowledge.

In default of a clear definition of the thesis proposed to the Metaphysical Society, the prevailing thought in the minds of the disputants seems to me to have been, how far the belief in abnormal phenomena, commonly spoken of as miraculous, is consistent with such a belief concerning the laws of Nature as scientific men find themselves compelled to hold. The discussion had clearly an underlying theological character: to more than half the disputants (so at least it seems to me) the theological consequences of an alleged uniformity of Nature were the uppermost thought, and the feature of most pressing interest in the argument. It would be well, perhaps, if this theological bearing of the question could be avoided in discussion. We should be more likely to arrive at a conclusion as to what the uniformity of Nature means, and to what extent the principle is true, if we could regard it entirely as a natural question, and one to be answered upon the ordinary grounds of observation and induction: and I observe that Professor Huxley seems to recognize this view, or rather he regards the principle as one the truth of which is not proved, but which is valuable as a working hypothesis, and all the more valuable because it has never yet failed him. The separation of the principle from theological considerations is, however, practically impossible ; we must make up our minds to many a fight upon the frontiers of the natural and the supernatural. Not a few persons believe that the possibility of religious faith, at this epoch of history, depends much upon the conclusions to which they come concerning the laws and operations of Nature ; and I will not venture to deny that they who so believe have some reason to give for their belief.

It is in accordance with the statement just now advanced with regard to the close practical connection between the principle of the uniformity of Nature and theology that we find the said principle brought at once to the front in the Bishop of London's recent "Bampton Lectures," entitled "The Relations between Religion and Science." With the general argument and results of these undoubtedly able lectures I shall not here be concerned, but it will be much to my purpose to make a few observations upon what is said in the first of the series concerning the uniformity of Nature.

The earliest occasion upon which the phrase appears is to be found in the following sentence: "It will be admitted that the Supreme Postulate, without which scientific knowledge is impossible, is the Uniformity of Nature." *

Now, a postulate is a proposition which is granted as the basis of an argument, because its truth is conceived to be self-evident ; or at all events it is the simplest proposition to which a chain of reasoning can be reduced, and, if it be not granted, all further argument is impossible. Thus, Euclid's first postulate is, that from one point a straight line can be drawn to any other point. But surely it can scarcely be said of the uniformity of Nature that it has anything of this simple and self-evidencing character. The question, moreover, is not whether scientific knowledge be possible or impossible without it ; if impossible, so much the worse for scientific knowledge. The question still recurs, Is the principle true ? Moreover, can it be averred that scientific knowledge *is* impossible without this postulate? If so, why is it that the principle is not asserted in Newton's "Principia," or Laplace's "Mécanique Céleste," or the various treatises on light, heat, electricity, botany, and what not? Certainly it seems to me extremely doubtful whether the "Supreme Postulate" either is admitted, or ought to be admitted, as the basis of scientific knowledge.

I suspect, however, that the bishop does not intend the word Postulate to be taken in its strict scientific sense ; for he illustrates his position by reference to the discovery of the planet Neptune, which resulted from the assumption that the law of gravitation holds uni-

* Page 6.

versally, and that therefore the unexplained errors of Uranus were due to the action of an exterior planet. But this assumption was as different as possible from a postulate: it was only applying in a new way a law which had already been verified in so many and such diverse cases that there was scarcely the shadow of a doubt in the mind of any astronomer that it was, as its ordinary name professes it to be, *universal* throughout the material cosmos.

I am confirmed in this belief by finding the subsequent statement that "the uniformity of Nature is a working hypothesis, and it never can be more";* which agrees very much with the view propounded by Professor Huxley at the meeting of the Metaphysical Society. But I am not quite sure that this is consistent with a previous passage in the lecture, which runs thus:

> This, then, is the answer to the question. Why do we believe in the uniformity of Nature? We believe in it because we find it so. Millions and millions of observations concur in exhibiting this uniformity. And, the longer our observation of Nature goes on, the greater do we find the extent of it. Things which once seemed irregular are now known to be regular. Things that seemed inexplicable on this hypothesis are now explained. Every day seems to add not merely to the instances, but to the wide-ranging classes of phenomena that come under the rule.†

The truth of which I am not concerned to dispute; but the paragraph gives a very different complexion to the principle of the uniformity of Nature from that which belongs to it, when regarded as a postulate upon which all scientific knowledge depends.

The truth which I think *is* postulated in the case of Nature is that which is involved in the idea of cause and effect. The Bishop of London refers to Hume's famous discussion of this question, and his conclusion that there is nothing more in cause and effect than the notion of invariable sequence. This conclusion has often been controverted, and the Bishop of London refers to the arguments of Kant and of J. S. Mill: it seems to admit of a very simple and irresistible contradiction from the following consideration: It is easy to give instances in which an invariable sequence takes place, and yet the two events which follow each other are obviously *not* connected as cause and effect. Take the case of lightning and thunder: the thunder follows the lightning with invariable sequence, whether we chance to hear it or not, but the two are separate effects of the same cause acting under different conditions; and no rightly instructed person could imagine that one was the effect of the other. Or suppose that you shout, and produce two echoes from two rocks at different distances: these echoes will satisfy the condition of invariable sequence, and yet will manifestly not be related as cause and effect. Or, to put the case more generally, it is quite possible that a cause may produce more than one

* Page 29. † Page 27.

effect; and these effects being invariably connected will, by ignorant people, be regarded as cause and effect, which they will not be. In fact, the reference of one phenomenon to another as its cause, in consequence of invariable sequence, may have the same essential error involved in it as had the classical example of Tenterden Steeple and the Goodwin Sands.

What is necessary in order that one thing shall be regarded as the effect of another, which may be called the cause, is not only that there shall be an invariable sequence, but also that it shall be possible to assert that the one could not take place without the other, or something equivalent. This invisible, impalpable chain between the one thing and the other must be postulated by the human mind: it constitutes the idea of cause; every child knows perfectly well what it is, and the profoundest philosopher does not go far, if at all, beyond the knowledge of the child.

Let me support what I have been saying by a quotation from Whewell's "Philosophy of the Inductive Sciences":

We see in the world around us a constant succession of causes and effects connected with each other. The laws of this connection we learn in a great measure from experience, by observation of the occurrences which present themselves to our notice, succeeding one another. But in doing this, and in attending to this succession of appearances, of which we are aware by means of our senses, we supply from our mind the idea of cause. This idea, as we have already shown with respect to other ideas, is not derived from experience, but has its origin in the mind itself; is introduced into our experience by the active not by the passive part of our nature.*

And again Dr. Whewell writes:

That this idea of cause is not derived from experience, we prove (as in former cases) by this consideration: that we can make assertions, involving this idea, which are rigorously necessary and universal; whereas knowledge derived from experience can only be true as far as experience goes, and can never contain in itself any evidence whatever of its necessity. We assert that "every event must have a cause"; and this proposition we know to be true, not only probably and generally, and as far as we can see; but we can not suppose it to be false in any single instance. We are as certain of it as of the truths of arithmetic or geometry.†

Here is a true postulate; and if to the postulate that every event must have a cause we add these postulates, (1) that causes in Nature are always of the same kind and always act in the same way, and (2) that no new causes come into existence, we should go a long way toward making the uniformity of Nature, if not axiomatic, at all events capable of tolerably simple and satisfactory demonstration.

But these latter postulates will perhaps scarcely be universally granted. I understand those disputants, who in the Metaphysical Society's discussion laid so much stress upon the duty of examining

* Vol. i, p. 158. † Page 159.

into the truth of alleged phenomena lying apparently outside the circle of ordinary experience, to have argued that there might be causes of which ordinary physical science takes no account, and that you can not logically deny the occurrence of what may be called conveniently the "supernatural," unless you assert that the causes which are included in what we call Nature exhaust all possible forms of causation. Such an assertion would probably be rash, even if we took into account only the results which may be produced by the action of the human will. But so far as the physical investigator, the scientific discoverer, the man of science in the ordinary sense of the phrase, is concerned, he may consistently say that all causation of a spiritual or supernatural kind is outside his domain. He may say, "I neither affirm nor deny the possibility of events and phenomena which are not according to the ordinary course of Nature. I am content to take what is called the uniformity of Nature as prescribing the limit of my inquiries"; and he may be able to add, with Professor Huxley, that he has never yet found it to fail him. If it should fail him, the result might possibly be similar to that which mathematicians call the failure of Taylor's theorem, and might indicate, not that the theorem was faulty, but that in certain critical cases the ordinary law of the theorem would not apply.*

The discussion which precedes has been longer than I expected, but I could not well shorten it. Hitherto I have been chiefly engaged in what has been offered by others on the subject of the uniformity of Nature; I now proceed to suggest a view which, if it fails to give the reader's mind as much satisfaction as it affords my own, will at least, I trust, be deemed worthy of some consideration.

Strict views concerning the uniformity of Nature appear to me to date from the period when Newton first showed that the motions of the heavenly bodies could be made the subject of mathematical calculations, or rather of dynamical, for I am not speaking of those which are merely empirical. Newton, in fact, founded what we now call physical astronomy. If we look a little back from this period, we find the opinions of men of the most educated class very loose on the subject of Nature and Nature's laws. It is sufficient to refer to Sir Thomas Browne's belief, that intercourse was possible between human creatures and evil spirits,† and Sir Matthew Hale's often-quoted opinions and consequent judicial action in the case of witchcraft. There was much in popular superstition, much even in orthodox religious belief, and perhaps much in the tendencies of the human intellect, to suggest views of Nature which would now present insuperable obstacles to minds even of ordinary powers and proficiency, but which presented no such obstacles in what may be called the pre-sci-

* There are some passages in pp. 217–219 of the Bishop of London's lectures to which I would have referred had space permitted.

† "Religio Medici;" chap. xxx.

entific era of the world's history. Newton, or rather Newton as developed by Laplace and the French school of mathematicians, entirely changed the whole aspect of things. Laplace, with propriety, described his great work by the title of 'Celestial Mechanics': the purpose of the work, which it effected with singular skill, was the reduction of the whole system of the heavens to the condition of an ordinary mechanical problem—a problem, too, having the advantage that the bodies concerned are all moving *in vacuo*, and that therefore there are none of the difficulties of friction, resistance of the air, and the like, which interfere with the easy solution of terrestrial dynamical problems. To the mathematician the solar system is a set of small bodies, which for some purposes may be even regarded as particles, revolving in connection with one much larger and central body, under the action of mutual gravitation according to a certain simple law; while the earth, regarded by itself and with reference to the phenomena of its own revolution, is a rigid, slightly oblate spheroid, the motion of which in given circumstances constitutes one of the prettiest problems of rigid dynamics. It is difficult perhaps for any one, who has not gone through the study pesonally and practically, to conceive how completely to the mind of a mathematician the solar system resolves itself into a problem of bodies in motion *in vacuo*. But, as soon as the mind apprehends the solar system thus, it has found an instance of the uniformity of Nature upon a very large scale. The mathematician who is capable of selving the problem of the planetary motions, as Laplace and Lagrange solved it, or who knows anything of the motion of a rigid body revolving as the earth revolves, finds himself simply incapable of conceiving of anything but motion, according to fixed law, being found in the solar system; the uniformity of Nature in this department presses itself upon him with a power which he can not resist.

A mathematician, for example, would find himself entirely precluded from sympathizing, in the most distant manner, with the view expressed by Mr. Ruskin at the meeting of the Metaphysical Society. The standing still of the sun, of which Mr. Ruskin speaks so pleasantly, means the stopping of the revolution of the earth, for the motion of the sun is only the earth's revolution; consequently, what is called the standing still of the sun involves tremendous dynamical consequences, an utter disruption of everything upon the earth's surface, a return of chaos, or I know not what. I am not criticising the expression as to the sun standing still, used in the book of Joshua without any attempt at scientific language. What the actual fact was to which the language used refers, and what was the actual phenomenon, I can not undertake to say; but if we adopt the phrase into the language of the nineteenth century, and in that language speak of the news of the sun standing still as a thing which need not surprise us, but which we have rather expected than otherwise, then I say that to the mathematician the language involves a necessary catastrophe, and that if the sun did stand still, even for a moment, no one would be left to tell the tale.

It is true that all men are not mathematicians, and that it is impossible for a mind which has not studied physical science mathematically fully to estimate the impression of contradiction and impossibility produced upon the mind which has so studied by an allegation of any irregularity in the clock of Nature. Be it observed that the belief in the uniformity of such a phenomenon as the rising of the sun, or of the effect of the moon on the tides, or of such observed facts as precession and nutation, and many others, is to the mathematical physicist something different in kind from that which arises from mere experience. If you say that the sun has risen millions of times already, and therefore will probably, or almost certainly, rise to-morrow, you offer a good presumptive argument; but it is not the argument which chiefly weighs with the man who knows what the rising of the sun means, and what would be the mechanical result of his failing to do so. My belief, however, is, that the feeling of certainty as to natural phenomena, which such men as Laplace felt for the first time in human history, has percolated (so to speak) through the strata of human intelligence until it has become the common property of almost all. The whole aspect of Nature has been changed; and many a man feels a persuasion of the existence of something which may be described as uniformity, and in virtue of which he questions or doubts or denies many things which would have been accepted as possible or probable in the seventeenth century, without knowing or being able to explain upon what his convictions rest.

Hence, according to my view, the uniformity of Nature, instead of being capable of being defended as a postulate, is, so far as it is true, the result of very hard scientific fighting. In the region of celestial mechanics it may be said to have gained absolute sway, because the motions of the heavens resolve themselves into the ordinary laws of mechanics, supplemented by the law of universal gravitation; and from this region there is a very intelligible tendency to extend the assertion of the principle to other departments of scientific investigation. Such extension, however, must be made with caution; even in the solar system itself, the moment we go beyond mechanics, all uniformity appears to vanish. With regard to size, arrangement, density, in fact every element of planetary existence, variety, which defies all kind of classification, not uniformity, is the undoubted order of Nature.

There is a striking paragraph on this subject from the pen of no less a man than Alexander von Humboldt, which it may be well to quote in this connection. After speaking of the absence of all known law connecting the various planetary elements, their magnitudes, densities, etc., he proceeds thus:

We find Mars, though more distant from the Sun than either the Earth or Venus, inferior to them in magnitude; being, indeed, that one of the long-known greater planets which most nearly resembles in size Mercury, the nearest planet to the solar orb. Saturn is less than Jupiter, and yet much larger than Uranus. The zone of the telescopic planets, which are so inconsiderable in point of volume, viewed in the series of distances commencing from the Sun, comes next before Jupiter, the greatest in size of all the planetary bodies; and yet the disks of these small planets (whose apparent diameters scarcely admit of measurement) are less than twice the size of France, Madagascar, or Borneo. Remarkable as is the small density of all the colossal planets which are farthest from the Sun, yet neither in this respect can we recognize any regular succession. Uranus appears to be denser than Saturn; and we find both Venus and Mars less dense than the Earth, which is situated between them. The time of rotation decreases on the whole with increasing solar distance, but yet it is greater in Mars than in the Earth, and in Saturn than in Jupiter. Among all the planets, the elliptic paths of Juno, Pallas, and Mercury have the greatest eccentricity, and Venus and the Earth, which immediately follow each other, have the least, while Mercury and Venus (which are likewise neighbors) present in this respect the same contrast as do the four smaller planets,* whose paths are so closely interwoven. The eccentricities of Juno and Pallas are nearly equal, but are each three times as great as those of Ceres and Vesta.†

I will not prolong the quotation, but will add the following sentences, which contain the result which I wish to enforce:

The planetary system in its relations of absolute magnitude, relative position of the axes, density, time of rotation, and different degrees of eccentricity of the orbits, has to our apprehension nothing more of natural necessity than the relative distribution of land and water on the surface of our globe, the configuration of continents, or the elevation of mountain-chains. No general law in these respects is discoverable, either in the regions of space or in the irregularities of the crust of the earth. They are *facts* of Nature which have arisen out of the conflict of various forces acting under unknown conditions.‡

In other words, from the point of view now under consideration there is no such thing as the uniformity of Nature.

Nevertheless, the instinct of seeking uniformity in other departments, when it has been discovered in one, and that an important department, is not only intelligible but is of the highest value as a help in the pursuit of knowledge. Professor Huxley, as we have seen, describes the principle as a working hypothesis, which has never failed him; and, so regarded, it can lead to no error, and it may lead to the discovery of new truth. If uniformity be wrongly assumed, the results obtained may be erroneous, or they may not; examination and experiment will show which they are; a working hypothesis may always be freely granted to an investigator, but it must not be confounded with a postulate upon which the whole body of science rests.

Let me illustrate the character of a working hypothesis by a second

* This was written when only four asteroids were known. While this article is passing through the press the discovery is announced of the 249th asteroid!

† "Cosmos," vol. i. (Sabine's translation). ‡ Ibid.

reference to the discovery of the planet Neptune. Two working hypotheses were necessary in this case. First, there was the great hypothesis of gravitation according to the Newtonian law. But, secondly, it was necessary for the purpose of the calculation to make some assumption concerning the supposed planet. It was, accordingly, assumed that Bode's empirical law of planetary distances was true, and that, if the planet existed, its distance would be given by this law. The position of the planet was determined by the remarkable calculations of Adams and Leverrier; and what was the result? That the first hypothesis was confirmed, if it needed confirmation, and that the second was exploded, when the distance of Neptune came to be determined by actual observation. Thus a working hypothesis was proved to be false; but no harm was done. Neptune was discovered, though his distance had been wrongly assumed; the working hypothesis had fortunately been near enough to the truth for the purpose in hand, and, having served that purpose, it could be flung away.

But in speaking of a working hypothesis it should be carefully borne in mind that the very epithet *working* indicates limits within which the work must take place. The hypothesis of the uniformity of Nature, being founded upon or suggested by the discovery of uniformity in a certain department, must be carefully confined to similar departments, or, at all events, must be regarded with suspicion if it goes beyond them. We have already seen that if an astronomer, from the uniformity of mechanical action in the solar system, should conclude that there was some kind of uniformity in the configuration and the relations of the elements of the system, he would find himself deceived. Speculations concerning such uniformity are nevertheless very tempting. Kepler, as will be remembered, could not resist them, and got into some quagmires in consequence. But the temptation must be resisted; an assumed uniformity may lead to serious errors, if it goes beyond the strictly physical region to which it belongs.

And this view of the matter leads, as it seems to me, to sound conclusions, with regard to the relation in which the truth of the uniformity of Nature stands to truths, or supposed truths, of a different kind.

Take, for example, the case of alleged apparitions. I imagine that the tendency in the minds of not a few among us is to ignore apparitions utterly and completely. They are supernatural, and that is enough; they do not conform themselves to the recognized laws of mechanics, optics, acoustics, motion. This is a rebound from the old facility in accepting tales of demonology and witchcraft in pre-scientific times, and it has much to say for itself. Nevertheless, it is scarcely philosophical, and is in no wise demanded by the requirements of science and the conditions of scientific progress. A man may be perfectly orthodox in his physical creed, and yet may admit the weight of evidence in favor of certain alleged phenomena which will not square themselves with physics. Such alleged phenomena are not necessarily in contradiction to physical truth, they lie rather in another plane; they are like two lines or curves in space, which do not meet, and therefore can not cut each other. There are matters of the highest moment which manifestly do lie outside the domain of physical science: the possibility of the continuance of human existence in a spiritual form after the termination of physical life is, beyond contradiction, one of the grandest and most momentous of possibilities, but in the nature of things it lies outside physics. Yet there is nothing absolutely absurd, nothing which contradicts any human instinct, in the supposition of such possibility; consequently, the student of physical science, even if he can not find time or inclination to look into such matters himself, may well have patience with those who can. And he may easily afford to be generous; the field of physical science is grand enough for any ambition, and there is room enough in the wide world both for physical and for psychical research.

In truth, a wide-spread rebellion among some of the most thoughtful of mankind must be the result of any attempt to press the supposed principle of uniformity to the extent of denying all facts and phenomena which do not submit themselves. Religious faith is necessarily conversant with such facts and phenomena; and though even here a familiarity with the conclusions of science may be useful in steadying the mind and fortifying it against superstition, still there are supernatural truths bound up with the Christian creed, toward which it behooves all to bow with respect, and which can not be refuted by any appeal to the uniformity of Nature.

For Nature can only be uniform when the same causes are at work; and to declare an alleged fact to be incredible, on the ground that it does not conform to the natural order of things, can only be reasonable upon the hypothesis that no new influence has been introduced in addition to those which the natural order of things recognizes. But such an influence may be found in the action of will, or of some spiritual energy which does not exist in the ordinary natural order.

For example, it would be unwise absolutely to deny on *a priori* grounds the history of the stigmata of St. Francis of Assisi. There are not wanting examples to show that physical results of a remarkable kind can be produced by abnormal and excessive action of the affections, and feelings, and imagination. Recently recorded cases seem to invest even with a somewhat high probability the alleged experience of St. Francis.

I am not of course committing myself to any opinion as to the spiritual corollaries which may follow from an admission of the reality of the stigmata; one person may say that they have great religious significance, another that they are a curious instance of the physical effect of the imagination. I only argue that they must not be at once brushed away in deference to some supposed law of uniformity.

Still less is it wise to deny the possibility of events, recorded in the life of one greater than St. Francis, on the like ground. I am not going into the argument concerning the miracles and resurrection of the Lord ; but I wish to suggest that if the potency of a divine will be admitted, we have in the case of these events to take account of a power which does not present itself in the discussion of natural phenomena. We may well as philosophers admit, in consideration of the special circumstances of the case, the possibility of these supernatural facts, while prizing the principle of uniformity as a working hypothesis, or as more than this. For in truth even the action of the ordinary human will introduces strange breaches of uniformity into Nature. Conceive some observer endowed with human scientific faculties contemplating this earth of ours in the pre-human period. He sees the continents covered with forests, beasts of all kinds disporting themselves in the same, a great vigor of vegetable and animal life both in the sea and on the dry land. But all is absolutely wild, not a single glimpse anywhere of human purpose and contrivance. Suppose our observer to speculate upon the future of this scene of life and activity by the help of the working hypothesis of the uniformity of Nature, of which we will liberally allow him the use out of the scientific repertory of our own times. Would it be possible that this working hypothesis could present to his view, as a possible future of the globe, anything essentially different from what he could then see? The limits of land and water might have been observed to vary, and further variation might be anticipated ; volcanic action would have been seen to be very active, and it might be expected that volcanoes would still be a potent agent ; nay, I will even suppose that an observer is keen enough from his observations to deduce the theory of evolution, and so to expect that the flora and fauna which he witnesses are in process of transformation into something higher ; but could he possibly, in his happiest moment, and when his genius was highest, ever have con ceived or guessed the change which would come upon the globe when man appeared as the head and crown of the creation? It is not that man would be a stronger, or more active, or more crafty beast, than had ever appeared before, but that he would be a new creature altogether ; a creature with plans and purposes of his own, capable of saying, "I intend to do this or that, and I will do it" ; a creature, in fact, with a will which, joined to an intelligence infinitely higher than anything exhibited before, would enable him to treat the earth as his own, to subdue the powers of Nature, and fashion the earth's surface after his own pleasure ; which also would make him a moral agent, and so a creature different in kind from all those which had preceded him. This, however, is not the point upon which I intend to dwell now ; what I wish to point out is, that the appearance of man upon the earth would break to fragments any theory which an observer might have formed with the aid of the working hypothesis of the uniformity of Nature. The forests disappear, except so far as man finds them convenient; the land is tilled; the rivers are tamed; houses are built; ships float upon the sea; everything is regarded with reference to human comfort, and the will of man has utterly transformed the whole surface of the globe. The uniformity of Nature, as Nature had been known or manifested hitherto, is altogether set aside by the action of the will of man.

These examples may be sufficient, or at all events may help, to show the manner which the hypothesis of the uniformity of Nature must be regarded in order that it may express the truth. For my own part, I have no desire to speak lightly of it, or to despise it as a scientific guide. I have no sympathy with that opinion of Cardinal Newman, quoted by Dr. Ward at the meeting of the Metaphysical Society, to the effect that England would be in a far more hopeful condition if it were more superstitious and more bigoted. When he adds "more disposed to quail beneath the stings of conscience, and to do penance for its sins than it is," I allow that the words may admit of a wholesome meaning; but superstition, if I understand what is meant by the word, is an immeasurably and unutterably evil thing: it is the substitution for truth of that which is not truth; it is something which, from its possible poetical accompaniments, may be tolerable to man, and nevertheless must, as I conceive, be infinitely intolerable to God. But there is no occasion to sigh for a little more superstition, in order to counteract the evils which may arise from a one-sided view of Nature; nor are superstition and bigotry the best guides to true penance: the thing really to be desired is a symmetrical and equal-handed dealing with human and divine knowledge. In the one department, the uniformity of Nature may be accepted as a valuable working hypothesis; in the other, we contemplate God without any hypothesis at all, as the Author and original Cause of Nature, of whose will uniformity and variety are equally and co-ordinately the expression and the means of manifestation to human intelligence.

To sum up the views which I have endeavored to express in this paper: I trace the belief in the principle, described by the phrase "the uniformity of Nature," to the direct and indirect influences of the successful application of mathematics to the physical theory of the solar system. The principle so established may be used as a working hypothesis in physical investigations, so far as it predisposes us to seek for law and order in all parts of creation. But it must not be dealt with as an absolutely true principle, if for no other reason at least for this, that it has not been found practicable to define its meaning with precision. And especially we must take care not to assume it even as an hypothesis, except in cases in which it is quite clear that nothing but physical causes are concerned. Which last consideration should be regarded as a warning that the introduction of the principle into theological questions may very possibly lead to most erroneous conclusions.—*Nineteenth Century*.

SKETCH OF PROFESSOR ALPHEUS HYATT.

By RALPH S. TARR.

PROFESSOR HYATT was born April 5, 1838, in Washington, D. C. He attended various schools, among them the Maryland Military Academy, then under the direction of Captain Allen, an ex-officer of the regular army, an old-fashioned teacher, and somewhat of a naturalist. He entered the class of 1860 in Yale College, but after the Freshman year he left the institution to travel for a year in Europe. Returning, he entered the Lawrence Scientific School at Cambridge in 1858, where he took the highest degree, under Agassiz, in 1862.

His parents intended that he should become a merchant; but this was not congenial to the youth's natural tastes, and it was considered the next best course for him to study law. After pursuing for nearly two years studies which were distasteful to him, he finally broke away from college and went to Europe. Upon his return he determined to learn engineering. Thinking that a course in geology would be an excellent introduction to this branch, and attracted by the great name of Agassiz, he began to study that science at the Lawrence Scientific School. While at Cambridge, being attracted by a fine collection of Ammonites, he asked permission to study them, and, after graduation, published a monograph upon them. After a period of service as captain in the army he renewed his studies under Agassiz, in a class which included such students, since become eminent naturalists, as A. E. Verrill, A. S. Packard, N. S. Shaler, S. H. Scudder, F. W. Putnam, E. S. Morse, A. Agassiz, Theodore Lyman, J. A. Allen, and A. S. Bickmore. He afterward went to Salem, where Putnam was curator in the Essex Institute, and in 1867 became one of the curators. Morse and Packard afterward came in, and the four founded and for some years edited the "American Naturalist," which is now published in Philadelphia. These same young naturalists were also instrumental, together with officers of the Essex Institute, in founding the Peabody Academy of Sciences at Salem. They formed the first scientific staff, and together planned the museum, in which Professor Hyatt was appointed a curator in 1869. In the year 1871 Professor Hyatt was elected Custodian of the Boston Society of Natural History, and in 1872 he went to Europe, with his family, to finish the studies on Ammonites which he had begun in the Museum of Comparative Zoölogy in 1861. In 1881 he was elected Curator of the Boston Society. In addition to this he is unofficially in charge of the fossil cephalopods of the Museum of Comparative Zoölogy at Cambridge, and is Professor of Zoölogy and Paleontology in the Massachusetts Institute of Technology. He also has a class from Boston University, and in connection with the Boston Society is manager of the Teachers' School of Science, which was founded in 1870-'71, for the purpose of giving lectures to teachers in Boston and vicinity.

The Society of Naturalists of Eastern United States, founded in 1883, really arose from an idea of Professor Hyatt's that there should be a society representing the practical side of natural history. He communicated his ideas to Professor Clark, of Williams College, who realized the value of the plan; and it was mainly through the executive ability and energy of Professor Clark that the first meeting was called at Springfield. Professor Hyatt was elected first president of the society for a term of two years. In 1869 he was elected Fellow of the American Academy of Arts and Sciences, and in 1875 he became Fellow of the National Academy.

In his scientific researches Professor Hyatt has been exceedingly active. He first published an article upon "Beatreccia," a large and curious fossil first described as a tree, and then successively placed by different authors in all the several classes of Invertebrata, till at last, by another paper of Professor Hyatt's, it has been again shifted to the Protozoa. In 1866 appeared his "Observations on Polyzoa," an article of importance at that time, upon the structure of this curious and beautiful group of fresh-water animals. This was followed, in 1867, by an article upon "Parallelism between Different Stages of Life in Tetrabranchiata," and in 1872 by an important paper upon the "Fossil Cephalopods of the Museum of Comparative Zoölogy." In these and other subsequent pamphlets upon the fossil cephalopods he has steadily endeavored to elaborate a practical demonstration of the theory of evolution, and to illustrate the laws by which this has taken place among the cephalopods. One of his best works is "Revision of North American Poriferæ," the only work on North American commercial sponges, and one which is recognized throughout the world as one of the finest monographs of Porifera ever published. The field was entirely unexplored, and the group one of the hardest in the animal kingdom—so hard, in fact, that few naturalists have ever touched it. In his "Effects of Gravity upon Forms of the Shells of Planorbis," Professor Hyatt shows how important the action of gravity has been in modifying the shape of the shells of Ammonites and other animals, pointing out many cases where it has undoubtedly fundamentally affected the forms of shells and the growth of the parts and organs of the animals, and produced specific and generic modifications. Some of Professor Hyatt's most important theories have been set forth in an extensive paper, entitled "Genesis of Tertiary Species of Planorbis at Steinheim." It covers one hundred pages, quarto, and has nine plates. Professor Hyatt went to Steinheim with the intention of making additional observations and proving Hilgendorf's theory of the evolution of Planorbis, which was then recognized by paleontologists in Europe as the only positive demonstration of the theory of evolution.

He obtained a much larger series of Planorbis than Hilgendorf had, and was obliged to prove that, although there was a general gradation from the flattened species to the spiral, through many intermediate forms, it was not true that the series of species succeeded each other in time, as claimed by Hilgendorf. All the species, in all their curious modifications, were found together in the lower stratum. Theoretically a graded series was traceable ; and no doubt the flattened spiral forms were the ancestors of the more conical spiral forms. He also pointed out the marked resemblance between diseased and wounded individuals of a species, and the degraded form and the correlations of these with the transformations taking place in the old age of other and healthier species of the same group. He attributes his result to the use of mechanical methods. The shells were gathered in bags, carefully labeled, from each stratum, taken home, sifted through graded sieves constructed for the purpose, and every specimen, to the number of several hundreds in each bag, was thus necessarily passed through his hands. Professor Richard Owen, the eminent anatomist, Director of the British Museum, has said of this memoir, "It is a model of the mode in which such researches should be conducted." Besides these, Professor Hyatt is the author of many smaller papers upon nearly all subjects relating to natural history, and he has described many new genera of cephalopods.

Professor Hyatt has discovered that evolutionary changes in general were much more rapid in earlier ages than now, and could be compared closely with the isolated cases of very rapid evolution of forms in such limited localities occurring in later times, as at Steinheim. For instance, in the Silurian period there was a continual struggle for better adaptation to the environment. In other Paleozoic ages, also, evolution must have been rapid to have accounted for the observed changes. It must have been particularly rapid immediately after the groups or individuals originated, and thus should be represented as expanding suddenly from their point of origin, like the spokes of an expanded fan. He further believes that evolution of Cephalopoda has taken place both by progression and retrogression, in four branches. From the straight orthoceratic forms all fossil and modern Cephalopoda have descended. To use his own words : "The *efforts* of the Orthoceratite to adapt itself fully to the requirements of a mixed habitat gave the world the Nautiloidea ; the *efforts* of the same type to become completely a littoral crawler developed the Ammonoidea. The successive forms of the Belemnoidea arose in the same way ; but here the ground-swimming habitat and complete fitness, for that was the object, whereas the Sepoidea represent the highest aims, as well as the highest attainments, of the Orthoceratites, in their surface-swimming and rapacious forms." No better group for the study of evolution is found in fossiliferous beds, for in the shells every step of growth can be traced, and it can be seen that the coiled forms all go through the orthoceratitic or straight stage, or an approximate form, at an early embryological period. In these shells, too, all varieties, by disease or accident, are clearly shown, and this has led to the well-supported theory brought forth by Professor Hyatt, that much of the evolution of Cephalopods has been directly caused by pathological conditions—accidents or diseases transmitted to successive individuals, until they become firmly established inherited variations, and lead, in the Cretaceous period, to the death of one of the four orders of cephalopods, the Ammonoidea.

Among the subjects upon which Professor Hyatt is at present at work is his "Theory of Cellular Tissues" just published. This contains his theory of the origin of sex, which is one of the most important that he has ever published. It is that the nuclei of cells are both male and female; that gradually in some cells one element, perhaps the male, might predominate, while in others the female would be strongest. Thus we would have the metazoa stage, where the male and female cells are distinct from each other, but still mixed in the same layer. This specialization goes on until in the cœlenterates we find special layers of cells especially adapted to perform the function of male or female elements, and later, in the vertebrates, separate animals represent the separate elements. This theory he supports by many interesting facts. In the same paper he endeavors to show that sponges are intermediate between metazoa and protozoa. It is very well established that the body-cavity which immediately surrounds the stomach of all vertebrates is homologous to the sacs which spring out from the body-cavity of cœlenterates, and Professor Hyatt's theory is that these sacs are homologous to the branching cavities and sacs which spring from the central cavity in sponges, and further that these fundamental structural modifications originated independently in sponges, in cœlenterates, and probably in vertebrates, from ancestors which never possessed any such characteristic.

The most useful work which Professor Hyatt has done, and that for which he deserves much credit, is in connection with popular science-teaching. His way of teaching is original, and intended to inspire the student with a love for natural history, by teaching him to look about for himself and observe what there is to see. His first interview and study with Louis Agassiz had much to do with shaping his course, and formed the basis of his system of teaching. Since this study has had such an important bearing upon his life, we reproduce the account of it in Professor Hyatt's own words. Professor Hyatt says: "He gave me a Pentacrinite, or stone-lily, a rather complex fossil, and told me to study it. This I thought to be easy work, so I took a stroll in the afternoon and thought little of it. Next morning he came up to my table and asked me what I had found. I had never studied from Nature before, and began giving a very general description, saying that it was a fossil petrifaction, etc., and had what appeared to be the beginning of a stem. When I got to this point, he said, in an impatient tone: 'Stop! stop! you don't know anything about it. It is just what I expected. You haven't told me anything that *you* know. Look at it again and tell me something that you see for yourself!' I had faint book remembrances, and had been relying upon these. Taken all aback at this, I began to work. I thought about it all day and dreamed about it at night. Next morning I began to tell him what I had found out, and before I was one quarter through he stopped me, saying, 'That is good; but,' he added, 'you have not yet told me what I want.' With this he pointed to the side of the room where star-fishes, ophiurians, and sea-urchins were kept, and told me to see what more he wanted. In this blind way, with no further hint, I worked unsuccessfully for a long time; then I found that I had omitted the most conspicuous point, the star-like appearance. Not knowing whether this was of importance or not, I timidly reported at the next interview this resemblance to the star-fishes, and Professor Agassiz was satisfied. This burned into my mind the most important lesson of my life: how to get real knowledge by observation, and how to use it by comparison and inference." His acquaintance with Darwin, though confined to a few letters and a short personal visit while in England, had also a marked influence on his life, for he saw here the greatest of naturalists living in a simple, unostentatious manner, paying respectful attention to the studies of even comparatively unknown young naturalists, not anxious, above all things, to claim even that which was due him, but to render justice to the researches and ideas of others. This was so contrary to the usual practice of claiming all possible credit for intellectual results that it produced a profound impression upon Professor Hyatt, and it has influenced his life as it has that of many of the existing generation.

In teaching, Professor Hyatt uses books as little as possible; his lectures, and those which he superintends before the teachers in the Teachers School of Science, are delivered in a novel manner. Noted investigators are chosen to deliver the courses, which cover all branches of the objective sciences, as Professor Hyatt calls them, except astronomy. The idea of the lectures is to fit teachers for teaching elementary sciences in the public schools. In all cases except physical geography it has been found possible to give each member of the audience specimens of the thing described, so that they may follow the lecturer with the objects in hand, and take them away afterward.

In connection with this branch of instruction, the Natural History Society has issued a series of "Guides for Science-Teaching," of which nine have already appeared. They are all prepared under the guidance of Professor Hyatt, and he himself is the author of five, namely, "About Pebbles," "Commercial and other Sponges," "Common Hydroids," "Corals and Echinoderms," "The Oyster, Clam, and other Common Mollusks," and "Worms and Crustaceans." They are all models of simplicity, and contain a general review of the subject treated. They are intended to give just such accounts as are calculated to inspire the teacher with the truths of nature, and at the same time to teach her the simplest and best way of impressing the facts upon the minds of young pupils. In the introduction to the work on pebbles, the author says: "When properly considered, the essay is a series of suggestions, not an exact, cut and dried process. The memorizing of a single part will spoil the effect of the design. If the older scholar, when the lessons are finished, can not go through with the whole process and show what he has been taught with the specimens, it may be considered as proof that it has been done too quickly for him to fully comprehend each of the various steps by which a pebble is formed." The same plan as the one so successful in the Teachers' School has been suggested for the public schools—that each pupil be supplied with a specimen of the object, and that they be asked in turn to point out its features.

During the first few years after the United States Fish Commission was founded, Professor Hyatt spent his summers at the summer station, being allowed by the kindness of the commissioner to collect specimens to illustrate his lectures. Since then, with but one or two exceptions, his summers have been spent at Annisquam, near Gloucester, Massachusetts, where he can study in quiet seclusion. Previous to 1879 he had been in the habit of allowing a few students from the Institute of Technology to study with him in his private laboratory at Annisquam. Soon, however, the number of applications became too numerous, and he could no longer accommodate all, so that in 1879 steps were taken toward founding a general laboratory of natural history to be situated at Annisquam. Each summer the laboratory has been open under the directorship of Professor Hyatt, assisted by Professor Van Vleck, who has immediate charge of all the work. The laboratory was founded and is supported by the Woman's Educational Society of Boston, and is open to both sexes, investigators and teachers being given the preference. Each year the tables are full, sometimes there being as many as fifteen in the laboratory at a time, including some original investigators. The student is given a specimen, and is told to study it carefully and see as much as he can; then to verify his results by referring to Mr. Van Vleck at first, and then to books chosen by him. Professor Hyatt endears himself to all who study with him by his kindness and the interest which he takes in the individual work of the pupil.

A museum as large as that of the Boston Society of Natural History, under the charge of a man so full of original ideas and having the interest of science-teaching at heart, and, at the same time, having such an experience at home and abroad, must of necessity undergo important changes and become unique in its plan. To show the ideas which Professor Hyatt entertains, we quote from his annual report as follows: "It is quite possible to so arrange and subsequently conduct a museum that it will be as much more effectual in this way (educational) than any art-gallery or library, as Nature herself is greater and more instructive than any imperfect imitations of her ever set in frames or between the covers of books." In his report for 1882 he says that there have been many requests for reference series for consultation, and he suggests that money be raised for the purpose of placing series of specimens illustrating different natural groups so that they may be handled by those having sufficient interest in the subject. This is an important suggestion, and, if it can be carried out, will greatly raise the educational standard of the Natural History Museum. He also suggests that descriptive catalogues of the museum be issued and distributed at frequent intervals.

In order to render the museum a true guide to the study of natural history, to make it, in fact, a natural system in itself, and to illustrate all the forms in a definite and natural manner, Professor Hyatt has adopted a superior plan of arrangement. Let us take, for example, the mineral and geological collection, which is now nearly completely arranged. First of all, the elements are shown, then the elements which enter into rock formations in an elementary form. Then there is a series of what might be called rock-elements—that is, rocks which are composed of one mineral, such as mica or limestone. We are then prepared for the final stage of rock-mixtures—such as conglomerates, granites, etc. Next are taken up the rocks as they are formed, either sedimentary or igneous, and so on through the whole rock-world, going step by step in a most natural way from the simplest to the most complex, from the elements to their compounds. This is the natural system, and is being adopted in other departments of the museum.

Such is Professor Hyatt's work. He is a scientist in every sense of the word, and holds a high rank among naturalists. Still, he is able to find time to render science popular—a great work, which scientists are not apt to appreciate and which few try to do. It is an important work, and the only way firmly to establish science upon the world: and that small body of men who are so unselfishly devoting their time to this grand work are deserving of far more credit than those who selfishly shut themselves from the rest of the world, and laboriously work away at abstruse problems, which, after they are discovered, are put in such terms as to be unintelligible to the average person. We repeat it, that those who are doing their best to render science popular are doing far more for true science than those who purposely shun such work, and confine themselves to uninteresting and often unimportant problems.

CORRESPONDENCE.

A SIGNIFICANT ANALOGY.

Messrs. Editors:

When President White wrote his "New Chapters in the Warfare of Science" he could have had no idea that the same issue of your magazine which contained the first chapter on "The Doctrine of Comets" would also contain a striking illustration by another writer of a similar phase of the same conflict which he has so graphically portrayed.

According to Mr. White, the foolish notions and absurd superstitions which prevailed for so many centuries in regard to comets were due to the irregularity of their movements and the indeterminateness of their orbit. As soon as astronomers had calculated the orbit of a comet and foretold the exact time in which it would appear, "a true doctrine of comets" became possible and was accepted, at least, by the mass of intelligent persons.

Perhaps very few of your readers connected this article on comets with the one on "The Metaphysical Society" in your October number. Yet the passages that I am about to cite will, I think, bear me out in holding that, even among the most intelligent men of the present time, the same kind of ignorance of the phenomena under consideration leads to similar erroneous conclusions.

The very interesting discussion on the "Uniformity of Nature," by such representative men as Dr. Ward, Father Dalgairns, Mr. Ruskin, and the Archbishop of Westminster on the one side, and Professor Huxley, Mr. Bagehot, and Sir James Stephen on the other, at last reaches "no less weighty a thinker" than Dr. Martineau. After stating forcibly the philosophical reasons which make a belief in the uniformity of nature absolutely necessary, "so far as nature is purely dynamic and so far as force is measured by reason" (p. 817), he yet declines to accept this when man's mental nature is concerned.

"Doubtless," he says, "it will be replied that, as in the mind of man there is a free spring of force which is as yet undetermined, which is potential and not actual force, so there is behind nature a free spring of force which is as yet undetermined, which is potential and not actual nature—in short, a power above nature and capable of modifying it; in other words, supernatural, and that doctrine I should heartily accept. The uniformity of nature is the uniformity of force, just as the uniformity of reasoning is the uniformity of thought. But just as the indeterminateness of creative will stands behind the determinateness of the orbit of force, so the indeterminateness of creative purpose stands behind the determinateness of the orbit of thought or inference. I hold that man is not wholly immersed in dynamic laws, that, though our physical constitution is subject to them, our mental constitution rises above them into a world where free self-determination is possible" (p. 817). Have we not here, I ask, another case where "irregularity of movement" and "indeterminateness of the orbit" have produced confusion of thought and caused thinkers to regard as "free" that which, so far as we have any positive knowledge at all, we know to be determined. It would not be difficult to show either that the superstition in regard to "Free Will" has done even more harm than the belief that the appearance of comets betokened evil.

President White's article furnishes such an excellent answer to a pithy question put by Dr. Ward near the close of the debate, that I can not forbear to call attention to it. "Is it not better," he asks, "to have a vulgar belief in God than to have a fine susceptibility to scientific methods?" (p. 819).

During the long ages of ignorance and superstition to which Mr. White has called attention there existed what Dr. Ward wants—"a vulgar belief in God," and there was but a very slight "susceptibility to scientific methods." While it can not be said that even now the tendency toward the latter is very strong, or that a vulgar belief in the Deity has disappeared, yet I think it will be generally admitted that there has been some advance toward a recognition of the merits of the scientific method and some alteration in the beliefs about God; and I leave it to any competent and candid person to say which of these times has been the "better" for humanity.

Yours truly, R. M.

October 2, 1885.

CORPORATIONS AND THEIR EMPLOYÉS.

Messrs. Editors:

Dr. Barnard's well-timed paper calling attention to the lack of direction of the sympathy of corporation managers with their employés deserves a more general consideration than it will be likely to receive from them. As one directly interested in the labor problem, I wish to thank him for calling popular attention to the nearest way to mitigate some of the asperities of the situation, and for his efforts as Secretary of the Baltimore and Ohio Employés Relief Association.

Speaking from a close association with the class of labor he seeks to benefit, it is my belief that both it and the spirit of our people resent a "paternal care and solicitude" while welcoming a "friendly interest," and perhaps even a "guardian's care."

Some of the members of his Association have characterized it as "too paternal," and though it has done and is doing great good, not only for the Baltimore and Ohio employés but among employés generally, as an example of what can be accomplished, it is well to remember that "compulsory provision for their future welfare" excites opposition, and does not educate his "wards" as would a more friendly help.

This is indicated by the Pullman experiment, of which the popular judgment is: that it is not approved by the employés, and is not so successful as to deserve imitation by employers. G. C. HEWETT.

WINIFREDE, WEST VIRGINIA, *September* 16, 1885.

EDITOR'S TABLE.

PRESIDENT LESLEY'S ADDRESS.

THOSE of our readers who carelessly pass by the recent discourse of Professor Lesley before the American Association for the Advancement of Science without reading it will make a bad mistake. There is not much danger of this, for the address is sufficiently attractive and brilliant to engage general attention. Professor Lesley enforces many wholesome truths upon the students and devotees of science, and maintains a high ideal of the great purpose that should govern scientific pursuits. On these points we can have nothing to add. But there is a bearing of the whole discourse on common education which should not be overlooked. His address, in one of its chief aspects, is a counterblast against "cram" in science—against the mere accumulation of scientific facts—and it is a ringing demand for more persistent and concentrated labor in small and unobtrusive fields of investigation. His plea for what is called "dead-work" in science, as contrasted with more showy performances, is especially effective. But his observations on "the over-accumulation of scientific information" have an application outside the limits of strict research. "The science of learning and the science of knowledge," he says, "are not quite identical; and learning has too often in the case of individuals overwhelmed and smothered to death knowledge. The average human mind, when overstocked with information, acts like a general put in command of an army too large for him to handle. Many a vaulting scientific ambition has been thus disgraced. Nor is this the only danger that we run; for the accumulation of facts in the treasury of the human brain has a natural tendency to breed an intellectual avarice, a passion for the piling up of masses of facts, old and new, regardless of their uses." "Not only the avarice of facts, but of their explanations also, may end in a wealthy poverty of intellect for which there is no cure." "How much we know is not the best question, but how we got what we know." Professor Lesley touches upon the subject of general education from this point of view as follows:

I do not intend to discuss the subject, to define the quantity and quality of knowledge adequate for the various classes of human society, or to propose any plans for its distribution. All I wish to say about it is, that it seems to me Nature limits both the responsibilities of teachers and the rights of learners more narrowly than is commonly supposed. The parable of the sower is a good reference for explanation. Most of the surface of the globe is good for little else than cattle-ranches or sheep-farms, and the large majority of mankind must in all ages be satisfied with the mere rudiments of learning. What they want is unscholastic wisdom with which to fight the fight of life, and they must win it for themselves. Only a limited number of persons in any community can acquire wealth of knowledge, and the only thought on which I wish to insist is this: these few must also get it for themselves, and, moreover, must work hard for it.

It is a hackneyed aphorism that there is no royal road to knowledge, although an incredible amount of pains has been taken to make one. Nature in this affair, as usual, has been a good, wise mother to us all; for it is not desirable to make the acquisition of knowledge easy, for the main point in scientific education is to secure the highest activity of the human mind in the pursuit of truth—an activity tried and disciplined by hardship and nourished on hardy fare. The quantity of food is of less importance; everything depends on establishing a good constitutional digestion. The harder the dinner is to chew, the stronger grows the eater. Canned science as a steady diet is as unwholesome for the growing mind as canned fruits and vegetables for the growing body. The wise teacher imitates the method of Nature, who has but one answer for all questions: "Find it out for yourself, and you will then know it better than if I were to tell you beforehand."

The great vice of current education is here squarely hit. As Huxley says, it is "spoon-victuals"; acquisition made easy by elaborate simplification and explanation which leaves wholly out of view the fundamental truth that mental power can only be acquired through the effort of active exercise. This is the supreme requirement, but it is this which is everywhere, and by all pretexts and devices, evaded. We are still in the lesson-learning, print-worshiping stage of education, almost as much as they were when children were taught from the catechism—

"My book and heart
Shall never part."

But the true purpose of education, as can never be enough enforced, is not to learn lessons and get explanations from teachers, and to accumulate information, but to develop power in the minds of the young to observe carefully, to reason correctly, and to think independently about the things that are important and vital in the experience of life. The minds of the young require to be cultivated and trained in this kind of activity; but all the mighty apparatus of books, teachers, superintendents, and boards of education, backed by millions of money, instead of leading to this result, *stand in the way of it.* The two methods are incompatible. Listening to explanations and cramming the contents of books are radically antagonistic to thinking things out, and to that self-instruction the sole condition of which is mental effort, and that should be kept in view as the essential thing to be secured in all education of children and youth.

THE EPIDEMIC AT MONTREAL.

The terrible pestilence, which, for several months, has been raging in the beautiful city of Montreal, carrying away thousands of its inhabitants, teaches a painful lesson of the malign consequences to a community of ignorance and superstition when strong enough to set at defiance the resources that intelligent experience has furnished to arrest its progress. It is not as if the people had been struck by some new and mysterious disease before which they were powerless. It is not as with the plagues of former ages, when nothing was known that could be done to arrest them. The saddest aspect of the Montreal calamity is not that multitudes have been swept into unripe graves, but that this vast mortality could have been avoided. That small-pox is practically a preventable disease is established; but to what purpose, when all the apparatus of self-defense in a civilized community is completely paralyzed? A comparatively small element of the population, ignorant, prejudiced, and pious, makes a blind and desperate resistance to the only measures that can bring relief; and they resort to penance, invocation of saints, prayers to Heaven, and solemn processions, to arrest the course of contagion, over which these have no more influence than they would have to arrest the course of the St. Lawrence! The chief ravages of the disease have been confined to that portion of the French Canadians who were unvaccinated; but such has been the passion of religious fanaticism, and the intensity of race-hatred, that this small minority made a fight stubborn enough to defeat all effectual public action. There have been defiance of authority and constant danger of mob violence which have intimidated the controlling officials and so diminished their effectiveness. The authorities in charge of the leading hospital of St. Roche are said to have favored neither vaccination nor sanitation, and such was the inefficient and horrible condition of that old establishment that many advocated burning it down. The efforts to isolate cases of small-pox have been also desperately resisted, and, worst of all, the officials have misled the people as to the progress of the malady, and by inducing a false security have prevented that energetic private action which must be the main reliance in the last resort. A writer in a Montreal newspaper puts this feature of the case very forcibly. He says: "In the prevailing murmuring and complaint by people with their faces turned toward the City Hall, let us say that, had every man and woman in this city done his or her plain duty about small-pox, there would be no small-pox. It is one of the vices of our age, which Montreal manifests in a marked degree, that 'authorities' are expected to do for individuals what individuals should do for themselves. So far as laws or by-laws lead people to imagine that they can properly or safely divest themselves of any part of their personal responsibility, just so far are laws or by-laws only evil. There is a disastrous superstition abroad which leads people to believe in enactments and legislation. These things can not execute themselves, they can only be put into effect by deputies, often listless or ignorant, and nearly always much less interested in the execution of their work than the men who have thoughtlessly handed to them tasks which should never have been deputed. Whoever may be chargeable with the dire calamity upon us, grumbling will do no good now, and, if the reader wishes to aid the officials and other citizens who are busy fighting the plague, let him add himself to the Citizens' Committee. Work will be given him, and in its difficulty and importance he will have little leisure for complaint."

PARTY GOVERNMENT.

A NEWSPAPER brings us the fragment of a speech by Senator Hawley, in which he ventures for a moment upon the ticklish ground of defending partisanship, or the necessity of two parties. He had been previously glorifying one party—his own—with, of course, the due condemnation of the opposite party. One would suppose that he could spare the utterly wrong political party, and rejoice in its annihilation, so that the right party could have its perfect way; but he says we must have both, and in enforcing this idea he gives expression to the following curious bit of political philosophy: "It would be a lamentable day indeed for this country, or any other enjoying a free government, when it could be said that there were no parties —that lovely time that some long for, when there should not be enough of moral or intellectual life among the people to get up a single difference of opinion upon political affairs."

Senator Hawley seems here to think that the evidence and the measure of "moral or intellectual life" are seen in the power of "getting up differences"; while we have always supposed they were shown rather in the power of reaching agreement. Differences of views and opinions are certainly indicative of want of intelligence on the matters of disagreement; while "moral and intellectual life" is displayed in that activity of inquiry which leads to the attainment and acceptance of truth, and to consequent agreement. We are here, however, speaking from the scientific point of view, in which agreement in truth is the supreme end; while Senator Hawley is speaking from the political point of view, in which the errors of difference for partisan purposes are the supreme end. Nor would he have the higher step taken which leads to agreement, for that would end partisanship, and, according to his logic, if parties should come to an understanding on political principles, it would be fatal to free government. "Free government," then, depends upon ignorance, and must be destroyed by the progress of knowledge. Senator Hawley is a politician, and with him partisan politics is the end, with its fruits of office and power. Elections and campaigns are his means, and his sole condition of success is to be able to arouse voters to hot political strife. So he wants differences, because men will fight over differences but never over agreements. Differences in politics there certainly are, and must long continue to be: what we object to in Senator Hawley's political philosophy is, he demands that this low partisanship which he so enjoys shall be eternal, and that it would be a "lamentable day" when it comes to an end.

LITERARY NOTICES.

A Text-Book of Nursing. For the Use of Training-Schools, Families, and Private Students. By Clara S. Weeks, Graduate of the New York Hospital Training-School; Superintendent of Training-School for Nurses, Paterson, New Jersey. New York: D. Appleton & Co. Pp. 396. Price, $1.

Miss Weeks's "Text-Book" will be recognized as a marked advance in the literature of the subject which it considers. Nursing as a practical art grounded in scientific principles, and an important adjunct of the medical profession with its own schools, belongs among the useful hygienic improvements of the last few years. In its early stages, as was most natural, its class-books were crude and imperfect. There has been a very valuable literature pertaining to nursing, but it has chiefly consisted of "Notes," "Essays," "Fragments," and imperfectly compiled rules and suggestions which, however useful and indispensable, have fallen much short of the requirements of systematic study. There was room here, and urgent need for something better, which the author of this book, moved by her own unsatisfactory experiences as a student, has now effectively supplied. She has given us a volume conformed to the established habits of school-study, complete in its treatment of the several subjects with which the intelligent nurse should be familiar, well illustrated, with copious questions for class-exercise and review, and a full glossary of technical terms. Her contribution is certain to prove helpful in the work of education, and she may be congratulated on having done an excellent service in helping on the progress of her profession.

But the usefulness of the "Text-Book" will not be confined to the limits of the Training-Schools for Nurses. It is of far wider application, and should find place in every family. It is full of information, to which every woman who cares for the vital interests of her household should have access. Clearly, popularly, and attractively written, it can be understood by everybody, and women who never expect to go into the nursing business professionally will be much better prepared to meet the emergencies and responsibilities of domestic life—to deal with the sickness that is at some time inevitable—by reading and familiarizing themselves with much of the instructive contents of this work. A good deal in it is, of course, only for the regular nurse; but there is enough of general application, and even of almost every-day utility in household experience, to justify us in commending it cordially to all thoughtful mothers as one of the books that they should have always at hand.

The Study of Political Economy: Hints to Students and Teachers. By J. Laurence Laughlin, Ph. D., Professor of Political Economy in Harvard University. New York: D. Appleton & Co. Pp. 153. Price, $1.

Professor Laughlin in this useful little book aims to present the claims of the subject upon those engaged in education, to show its disciplinary value, and to give important hints and suggestions as to how it may be most successfully pursued. Notwithstanding all the discussion there has been as to whether political economy is a true science or not, or as to the validity or relative superiority of its different methods, the subject is one which engages wide attention and is of foremost interest and importance. It deals with what is going on and must continue to go on in society under good or bad guidance, and where knowledge is certainly better than ignorance. The author has therefore done an excellent and necessary thing in showing students how they can best proceed in informing themselves on political economy, whether they wish merely to get an acquaintance with its rudiments or to master the subject. He gives the list of a teacher's library selected from English, French, and German authors, which can not fail to prove useful.

Philosophic Series. By James McCosh, D. D., LL. D. Nos. I to VIII, 50 to 70 page pamphlets. New York: Charles Scribner's Sons. Price, 50 cents each.

It was a very happy conception of the able President of Princeton College and distinguished metaphysician, Dr. McCosh, to take up the most urgent and interesting philosophical questions of the time, and treat them in the popular way here adopted. There can be no doubt that philosophical speculation has a good deal about it that is progressive. As long as thinkers shut themselves up to such pure metaphysical elaborations as they can carry on in the restricted sphere of consciousness, the resulting movement will be round and round rather than an advance or ascent; but, when they seize the conception of philosophy in its broader aspects, and connect it with those large questions of Nature and life which have come into such prominence in recent times, a distinctively forward movement is the result. When such great new principles as the conservation of energy or the law of development are projected into the philosophical field, and their import is recognized by the speculative mind, onward movements which can be regarded as nothing less than a new departure are the inevitable consequence. Dr. McCosh is not the narrow type of man to blink or to belittle the significance of these mighty ideas which have been forced upon philosophy by modern science; he not only meets them, but he welcomes them as priceless contributions to knowledge, to be perhaps yet further interpreted and qualified, but, neither to be feared nor resisted. Aside from his mastery of general philosophical subjects, and his familiarity as a scholar with the history of speculation, his knowledge of science and his sympathy with it, and his thorough acquaintance with the critical issues which have become prominent in the thought of this generation, especially qualify Dr. McCosh to give instructiveness to such a series of essays as he has here undertaken.

No formal review of the work is here practicable; we can only indicate his successive topics. No. I considers "Criteria of Diverse Kinds of Truth, as opposed to Agnosticism." No. II, "Energy: Efficient and Final Cause." No. III, "Development: What it can do, and what it can not do." No. IV, "Certitude, Providence, and Prayer." No. V, "Locke's Theory of Knowledge, with a Notice of Berkeley." No. VI, "Agnosticism of Hume and Huxley, with a Notice of the Scotch School." No. VII, "A Criticism of the Critical Philosophy." No. VIII, "Herbert Spencer's Philosophy as culminated in his Ethics."

President McCosh is a Doctor of Divinity, and the course of topics in this discussion shows that it has been prepared with reference to its theological bearings. But the controversial element is moderate in tone, and is subordinate to the expository element. We commend the pamphlets for the clearness and instructiveness of their teachings on philosophical questions, without being at all committed to the author's conclusions respecting theology or morality. On these points he seems often to betray the weakness of the thorough-going partisan of a dogmatic system.

Special Report of the State Inspector (Minnesota) of Oils on the Illuminating Quality of Oils. By Henry A. Castle. St. Paul. Pp. 24.

The inspector relates that frequent and numerous complaints came to him during 1884 of the inferior illuminating powers and other poor qualities of the kerosene-oils used in the State. He sought explanations from the wholesale dealers and agents of the oil companies, but could not get satisfactory ones; and it was not till he had begun to take measures for enforcing the laws against selling adulterated or inferior goods, that proper notice was taken of his remonstrances. Then the agent of the Standard Oil Company made a confession presenting almost the identical statement made by Professor Peckham, in the June number of the "Monthly," of the deteriorated character of the burning-oils in common use and its causes; and we refer our readers to Professor Peckham's article for more specific information on the subject.

The Azoic System and its Proposed Subdivisions. By J. D. Whitney and M. E. Wadsworth. Cambridge, Mass.: Harvard Museum of Comparative Zoölogy. Pp. 250.

The authors review the whole literature of their subject, beginning with the reports of the Canadian and other British-American surveys, and following with those of the New England and Atlantic seaboard States, Texas, Arkansas, Missouri, Michigan, and Wisconsin, and the Government surveys in the West, for the purpose of ascertaining the condition of the theory of the Azoic system. The reports examined concern the results of forty years of work. In a second part they give a "*résumé* and general discussion" of their review, the result of which is to lead them to the conclusion that "the geology of a large portion of this country, and especially that of Canada and New England, is in an almost hopeless state of confusion"; and "that our chances of having at some future time a clear understanding of the geological structure of Northeastern North America would be decidedly improved if all that has been written about it were struck out of existence." This condition of things is largely ascribed to the erroneous observations and theories of the Canada survey, "which to a large extent have been adopted and blindly followed on this side of the Dominion boundary." Finally, "the present director of the Canada survey appears to be sincerely endeavoring to base his work on better methods than those current under Logan's administration. All who are interested in the solution of the difficult problems of Appalachian geology will sympathize with him in these efforts; for . . . that which is done in Canada will, *if well done*, be of great assistance to those working on the south side of the Dominion line."

The Grimké Sisters: Sarah and Angelina Grimké. The First American Women Advocates of Abolition and Women's Rights. By Catharine H. Birney. Boston: Lee & Shepard. Pp. 319. Price, $1.25.

The interesting characters to which this volume is devoted are now historic. The Grimké sisters have passed away, and the record of their remarkable careers will have a double interest: first, for those who knew, admired, and loved them; and, second, for all others who take interest in those great public events leading to the overthrow of slavery in this country, with which these ladies were early and long and intimately associated. Angelina and Sarah Grimké were gifted women of superior intellectual stamp and high moral aspirations, who gave their lives to the active promotion of various reforms with fearlessness, independence, and devoted purpose, to make the world better as far as lay in their power. They were both of a deeply religious cast of mind, and entered early into church relations in their native city of Charleston, South Carolina. But the perfunctory round of ordinary religious exercises could not satisfy them. Religion was in their blood, and the type of it was that of tragic earnestness. They were descended on the father's side from the Huguenots, and on that of the mother from the old Puritans, with whom religion was a stern reality. Possessing hearts sympathetic with the sufferings of their fellow-creatures, and heads endowed to discriminate the means of relief, they could not remain impassive in their Charleston environment. The subject of slavery, with which they had been, of course, long and painfully familiar, took hold of them as a matter of religious duty. They left the Episcopal Church because it seemed given over to worldliness, and was unmindful of its Christian obligations to the slave. Angelina joined the Presbyterians, in the hope of finding them more alive to their practical religious duties, and Sarah for the same reason, though still earlier, joined the Society of Friends. Both left Charleston and went to Philadelphia, where Angelina also became a Quaker. But after years of trial they withdrew also from the Friends' organization, for the same reason that it did not enter heartily into the rising movement for emancipation. Breaking away from all these restraints, they came out openly as Abolitionists, and devoted themselves with great zeal and efficiency to the propagation of antislavery views. They wrote much and forcibly, and at length took the field as speakers in Massachusetts with remarkable effect. They were both eminently qualified for this sphere of labor, but Angelina, the younger, had extraordinary accomplishments as an orator, and her lectures were attended by crowds of admiring listeners, although the appearance of women in the public lecture-field was at that time a novelty, and strenuously resisted by all conservative people.

Slavery is now gone, and a new generation has come upon the stage which knows little of the intensity of the struggle which led to its extinction, and the furious and maddened resistance encountered by its assailants; but in the records of that experience the names of the Grimké sisters will ever have an honorable and permanent place. Of their various efforts in other directions of social reform, their personalities, and their interesting private lives, we can not here speak, but must refer the reader to the memorial volume, which has been executed with fidelity and discriminating fairness by a loving friend. It will be sincerely welcomed by all who knew them, and will be found full of instructive interest by all who have an appreciation of strong, elevated, and heroic character.

State Agricultural Experiment Station, Amherst, Mass. Second Annual Report. 1881. C. A. Goessmann, Director. Pp. 166.

The varied contents of this report, and the fullness with which the experiments are described, testify to a year of busy work. Among the subjects of the experiments were commercial fertilizers, the specific action of different forms of potassa, the effect of fertilizers on fruit-trees, various leguminous forage-plants, injurious insects, the vitality of seeds, ensilage, foods, analyses of milk, testing of drinking-waters, feeding-experiments with milch-cows and pigs, etc.

Placer Mines and Mining-Ditches. By Albert Williams, Jr. Pp. 64.

This monograph was prepared to form a part of the census report on the statistics and technology of the precious metals. Placer mines, according to the author's statement, have the advantages of being usually more accessible and nearer to thickly settled and agricultural districts than the quartz mining districts, and of not requiring so large an amount of material for their working as quartz mines. The secondary nature of the gravel deposits in which they occur implies an average lower altitude than that of the quartz veins, from which they are derived by erosion. It is a fact that they occur at all altitudes up to 10,000 feet, the elevation of the placer in Alma township, Park County, Colorado. The average height of those mentioned in this report is more than 3,400 feet above the sea-level, while the average height of those in California, beach-sands excepted, is 2,600 feet. The total nominal capital of thirty-six placer mines is $35,115,000, or an average of $975,417 each, while the average par value of their shares is about $14.68. The placer mines being largely worked by the hydraulic method, the question of water-supply is an important one with them, and extensive ditching-works have been executed to secure water. Mr. Williams has reports of 10,783 miles of ditch-lines, which have a maximum capacity of 7,560,000 gallons per twenty-four hours, which cost for plant, excluding cost of water-rights, $27,056,942, and are maintained at an annual expense of $837,280.

The Influence of the Proprietors in founding the State of New Jersey. By Austin Scott. Baltimore: N. Murray. Pp. 26.

This is a study in the Johns Hopkins University Historical Series, by the Professor of History in Rutgers College, of the course of the development of the fundamental institutions of New Jersey from the *régime* laid down by the original proprietors.

Natural Co-ordination as evinced in Organic Evolution. A Paper read by William Fraser, M. D., before the British Association for the Advancement of Science at its Montreal Meeting, September 1, 1884. New Glasgow, Nova Scotia: George W. Chisholm.

If it would be too much to say that Dr. Fraser, in this philosophical essay, has solved the supreme question of the nature of that governing power by which an evolving universe works out its highest results, it is not too much to say that he has made a reasonable and a valuable contribution toward such a solution. We can not here give his closely knit argument, but must be content with indicating the ground taken. He begins by remarking that "matter and force constitute the present scientific basis of the natural universe; but as unco-ordinated entities they might remain forever inoperative." This idea is so illustrated and enforced as to bring out the necessity of affirming a presiding directive and co-ordinating principle as a part of the order and constitution of Nature, and without which development is a wholly inexplicable process. Dr. Fraser's statement of the case of evolution as against special creation, and in the variety of its proofs, is thus admirably summarized:

The persistency with which succeeding links in the same organic chain approximate to a common mean type, along with certain prevailing sentiments and supposed teleological implications, has influenced many naturalists to accept the doctrine of special creation as a satisfactory explanation of the origin of species; to believe that each distinct kind was immediately introduced with its present congeries of characters complete and immutable, adapting it to a prepared station, and having the principle of heredity so strongly implanted as to prevent its members from ever deviating beyond the limits of acknowledged specific divergence.

From studying the question under other aspects, some observers have been induced to adopt an opposite view, and to conclude that all actual diversities were potentially inherent in matter and energy at their original creation and disposition, and have been spontaneously evolved through natural causes, without any supernatural interference.

Having learned the apparent potency of natural means and methods in producing all past physical changes, they feel constrained to recognize these as fully adequate to sustain the whole sum of terrestrial activity, including the processes and products of organization; deeming it more credible that the total system of development, in common with all other material objects and events, should form an essential and interdependent part of the more comprehensive scheme of Nature, than that each distinct species should have its source in a miraculous act of creation.

Observing, under varying artificial conditions, the occasional production of several acknowledged varieties from a common stock, and the perpetuation of such only as can provisionally conform with the conventional requirements of their situations, they infer that species originated and have been transmitted in a similar way, but carried further and established more firmly, either in consequence of more powerful impulses or of greater time and opportunities afforded.

They also find that all the species of the same genus, inhabiting adjacent and intercommunicable areas, have closer structural relationships than those of more remote and mutually isolated regions, and that any differences which exist in the former case are superficial, as if the later divergences had rarely and but slightly affected their fundamental characters.

Fossils also are generally found more nearly allied to the fauna and flora of their own particular territory than to those of distant provinces; and in the later deposits more so than in those of earlier strata.

Paleontological arrangements likewise indicate a gradual advance from generalized to specialized forms, from the simple earliest structures up to the relatively complex types of the present age.

Embryological development also shows a general progress from the indefinite to the definite; all organic germs at their origin being scarcely distinguishable from one another; the earlier fœtal stages of many different classes of animals being almost parallel; and in the higher orders, their later phases being attended by a gradually decreasing number of companions, till man, the highest vertebrate, at length alone acquires distinctively human features. Besides, underneath certain diversities of surface, which constitute specific morphological distinctions, there is often a fundamental unity; the arms of a man, the flippers of a whale, the fore-legs of a horse, and the wings of a bird being constructed on essentially the same general pattern, though differing greatly in special details, as if a common ancestral organ had become differently modified in each particular case, in subordination to, and in conformity with, correlated conditions.

Rudimentary structures often show the potency of heredity in preserving parts long after they have ceased to be serviceable; and occasionally they represent the transition to some more complete and permanent advantageous acquirement.

In general, the more invariable and radical organic structures are diffused among much larger aggregates than are less permanent and less important ones.

The spinal column, which pertains to the whole vertebrate sub-kingdom, holds tolerably constant specific characteristics within the same class, whereas the dermal appendages not only manifest much diversity in different species, but often display considerable difference even in members of the same variety.

All these complex and diversified relations are considered indicative of community of origin, with subsequent adaptive modifications.

Certainly geographical distribution, geological succession, morphology, embryology, classification, and many other peculiarities of organization, such as its fundamental unity of composition, but more especially the fact, so far as has yet been proved, of the derivation of all observed individuals from more or less similar parent stocks, constitute a remarkable collection of accumulating and converging lines of evidence in favor of the doctrine of specific organic descent.

These proofs, however, are merely circumstantial; the relation of this problem to human experience being such as to render it incapable of demonstration; still, the gravest objection to the theory of organic transmutation is the difficulty of understanding how matters could have been so constituted and arranged that from simple and indefinite beginnings such wonderfully complex and determinate results could have been obtained. NATURAL SELECTION does not account for the origin of specific characters, but merely explains how, out of numerous so-called spontaneous variations, such only can be preserved as are in sufficient harmony with their environments.

And, while changing incidence of conditions is undoubtedly instrumental in determining organic sequences, it is important to ascertain what is the nature of the factors engaged, and how they coöperate in the evolution and establishment of distinct specific characters.

The main conception of Dr. Fraser's thesis may be gathered from the following passages:

The mere association of developmental impulses and envelopmental facilities and restraints could never of itself issue in any definite progressive result, unless subjected to the determination of some controlling principle of order. Hence the regularity, definiteness, and consistency observable in organic reactions and relations testify to the additional existence and jurisdiction of a supplementary principle of co-ordinative supervision.

As man, by factitiously arranging the means at his disposal in accordance with his needs and tastes, institutes systems of artificial co-ordination, so the spontaneous adjustment of organic activities, in subjection to, and in conformity with, prevailing correlated tendencies and requirements, constitutes a principle of NATURAL CO-ORDINATION. In the elaboration and establishment of specific organic results, this *principle* fulfills the two distinct though complemental offices of a *directive* and a *selective* function; the former determining each temporary step in the process, the latter deciding which out of many courses will be permanently or successively adopted.

In a dependent evolving system, with abundant accommodation, provisions, and protection, it might remain a matter of indifference what number and kind of forms were produced, as all would alike be preserved, each phase being simply a resultant of the interaction between inward efforts and outward restraints, without the intervention of any subsequent eliminating process. Here the principle of co-ordination could only have directive scope; but, in a circumscribed area with limited supplies and liability to invasion, as soon as the rate of production exceeds the means of support, co-ordination will assume a selective *rôle*, submitting the various competitors for the different accessible situations to prescribed tests, accepting only such as conform with the required standards, and rigorously rejecting all relatively unsuitable or incompetent ones.

Organization seems to have been planned and conducted according to some such method and design; *its potentialities, when properly supplemented, constituting an incalculable fund of transmutable and genetic energies, affording the principle of co-ordination enormous resources whereon to operate*, so as to render possible the realization of results practically inconceivable.

POPULATION BY AGES, UNITED STATES, NEW YORK, PHILADELPHIA, AND BALTIMORE. By W. S. LANDSBERG. Baltimore, Md. Pp. 30. Price, 10 cents.

THE author believes that the distribution of a population according to the ages of the individuals is not fortuitous, but is the result of the influences which all the circumstances of a people's life exert upon its existence, naturally conditioned by births and deaths. In the light of this view he discusses the lessons to be drawn from the vital statistics of the United States and the three cities named.

THE MINTING OF GOLD AND SILVER. By ALBERT WILLIAMS, Jr. Pp. 24.

THIS paper was prepared to form a part of the census report. Without attempting an exhaustive treatise on modern practice in minting, Mr. Williams reports upon the processes employed in the mints at Carson, Nevada, and San Francisco, California.

THE MODIFICATION OF PLANTS BY CLIMATE. By A. A. CROZIER. Ann Arbor, Mich. Pp. 35. Price, 25 cents.

IN this pamphlet the author discusses a subject concerning which our present knowledge is "scattered and unsatisfactory," and on which he desires to elicit more information. From the facts he has been able to adduce he concludes that enough has been observed to make it evident that variation is not accidental or at random, but is, at least in part, in definite directions and due to definite causes. "It seems to be established that as plants move from the locality of their largest development toward their northern limit of growth they become dwarfed in habit, are rendered more fruitful, and all parts become more highly colored. Their comparative leaf-surface is often increased, their form modified, and their composition changed. Their period of growth is also shortened, and they are enabled to develop at a lower temperature. These variations, if useful, may be accumulated by selection and inheritance."

Second Annual Report of the Bureau of Statistics of Labor of the State of New York, for the Year 1884. Charles F. Peck, Commissioner. Albany: Weed, Parsons & Co. Pp. 521.

The attention of the Bureau during the year included in the report was directed chiefly to the investigation of the prevalence of child-labor in the manufactories of the State, in which, in spite of adverse circumstances growing out of the defects of the law under which the inquiries were conducted, and of the difficulty of getting employers to give information, a great many valuable statistics and much important testimony have been collected. The facts relate to the employment of children; its influence upon their physical development; the opportunity afforded in connection therewith for moral and educational training; and its relation to the social, commercial, and industrial prosperity of the State. A considerable portion of the report is devoted to the subject of compulsory education, the importance of securing the enforcement of the law prescribing it, and the means of accomplishing it. An article on "Hygiene of Occupation," by Dr. Roger S. Tracy, of New York, is also included in the report. In the appendix are given a report on Pullman, Illinois; the memoranda of a committee visit to the houses of cotton-mill operatives in Fall River, Massachusetts; the labor laws of New York; and extracts from the labor legislation of other States and of England.

A B C Book. By Francis A. March. Boston: Ginn & Co. 20 cents.

Phonetic First Reader. By T. R. Vickroy. Cincinnati: Van Antwerp, Bragg & Co. 25 cents.

Anglo-American Primer. By Eliza B. Burnz. New York: Burnz & Co. 15 cents.

Pronouncing Orthography. By Edwin Leigh.

American Phonetic Primer. By Elias Longley. New York: E. N. Miner. 25 cents.

First Book in Phonetic Reading. Second Book. Third Book. Fourth Book. Fifth, or Transition Book. By Isaac Pitman. New York. Fowler & Wells Co. The set, 26 cents.

An article in the September number of the "Monthly" having caused some inquiry for phonetic primers, a number of these books are here noticed. They have the common object of making easy the first part of the process of learning to read by removing the difficulties of silent letters, and letters with several powers, to a later stage. The authors make the claim, and support it by abundant evidence, that children learn to read books in phonetic spelling, and then master the ordinary print, in less time than is commonly spent on the ordinary print alone. It is claimed, further, that in learning to read by the phonetic method the child's reasoning powers are stimulated, while if taught in the old way it forms at the outset a habit of dependence on the teacher which impedes all future progress. Some of these books recognize thirty-six, the others forty or forty-one, simple sounds in the English language, besides four or five diphthongs; and, as the common alphabet contains only twenty-three effective letters, it is variously extended by new letters and digraphs. Longley uses seventeen new letters; Pitman thirteen, with digraphs for the diphthongs; Vickroy eleven, with eight digraphs; while Mrs. Burnz uses but three, depending largely on familiar digraphs. Dr. Vickroy's reader has on the title-page a note, signed by Professor March as president of the Spelling Reform Association, in which he cordially recommends the book. As Mr. Pitman's books are published in England, the pronunciation which they represent differs slightly from American usage. Thus the vowel sound in *lair* is not distinguished from that in *layer; been* is represented as rhyming with *seen*, etc. Pitman and Longley use the continental vowel-scale, Mrs. Burnz the English, while March and Vickroy skillfully avoid conflict with either. Mrs. Burnz retains duplicate ways of representing several sounds, and a few other irregularities of the old spelling, claiming as compensation that her spelling departs less from the common mode than any other, and hence that a person whose education went no further than the phonetic stage could spell a letter so that it would not fail to be understood by any one who went through the spelling-book in the old-fashioned way. Dr. Leigh's "Pronouncing Orthography" retains the common form of every word, but silent letters are printed in hair-line type, and the significant letters are so modified that it is always plain what sound they stand for. Ten or a dozen primers and readers by various authors have been published in Leigh's pronouncing editions. Professor March uses Dr. Leigh's types for nine single letters and five digraphs in his "A B C Book." Words containing silent letters are postponed to a later stage. A part of his general method is to have the pupils begin to write with the first lesson, but this may be omitted if the teacher prefers. The transition from any of the primers mentioned above to common print is said to be easy, but, if it seems desirable to keep the pupils longer on the phonetic print, second readers or other supplementary matter can be had in most of the systems for this purpose.

Zoölogic Whist and Zoönomia. By Hyland C. Kirk. New York: McLoughlin Brothers. 104 Cards. Price, $1.

An attempt is made in these cards to combine amusement, as it is sought in playing whist, with instruction in the principles of a science. The cards, on which the classification of animals is graphically represented, are arranged in two packs of fifty-two cards each, one including the vertebrates, the other the invertebrates. Each pack is divided into four suits, representing the classes and thirteen orders. The rank of the orders being fixed according to numbers printed on the cards, the game is played as whist is played. The game of zoönomia is played with all the cards, or a smaller number, and is in effect an exercise on the qualities of the orders of animals represented upon them.

The Tehuantepec Ship-Railway. By E. L. Corthell, Civil Engineer. Pp. 32, with Plates.

This is the substance of an address that was delivered before the Franklin Institute in December last, in which the plan of the railway as projected by Captain Eads is explained, and its feasibility and the prospective advantages to be derived from carrying it out are considered.

Papers of the American Historical Association. Volume I, No. 1: Report of Organization and Proceedings. Pp. 44. No. 2: Studies in General History and the History of Civilization. By Andrew D. White. Pp. 28. New York: G. P. Putnam's Sons. Price, 50 cents each.

The American Historical Association was organized at Saratoga in September, 1884, with Andrew D. White as president, and Herbert B. Adams, of Cornell University, as secretary, for the promotion of historical studies, and has registered already, for a society so new, a large list of members. It will publish original contributions to history in the form of serial monographs, each complete in itself, bearing its own title, pagination, and price; but the monographs will be also numbered in the order of their publication, and paged continuously with the series, for the annual volume. They are sent to members of the Association who pay their annual fee of three dollars, and to other persons for four dollars a volume. The address of President White is a forcible presentation of the value of historical studies, and suggests ways in which they may be made most efficient.

Efficiency and Duration of Incandescent Electric Lamps. Report of Committee, Franklin Institute of Pennsylvania. Pp. 127.

A special committee was appointed by the Board of Managers of the Franklin Institute in November, 1884, to conduct examinations and make tests of the efficiency and life-duration of incandescent lamps. It having prepared a code of conditions to which all competitors were expected to conform, Weston, Edison, Woodhouse and Rawson, Stanley-Thompson, and White lamps were entered, for competition or for comparative examination. The history of the testing, its incidents, and its results, are recorded in detail in the report.

Transactions of the Sixteenth and Seventeenth Annual Meetings of the Kansas Academy of Science (1883, 1884). E. A. Popenoe, Manhattan, Secretary. Pp. 145.

The Kansas Academy is evidently a working body. This volume of the "Transactions" contains notices or abstracts of forty-nine papers and reports read at the two meetings, all of them of much local and some of considerable general interest. We specially notice the two presidential addresses. The first, by retiring President Dr. A. H. Thompson, is concerning the "Origin and History of the Academy," and gives a rapid review of the growth of scientific work in Kansas, and of the transactions of the fifteen previous annual meetings of the society. The other address, by Dr. R. J. Brown, is a discussion of the question, "Is a Geological Survey of the State a Necessity?" and presents summaries of the benefits that have accrued from their surveys in other States in which such works have been prosecuted.

The Hoosier Naturalist. Vol. I, No. 1, August, 1885. A. C. Jones and R. B. Trouslot, Editors and Publishers, Valparaiso, Ind. (Monthly.) Pp. 8. Price, 50 cents a year.

The editors claim to have in Valparaiso a rare combination of facilities to encourage the publication of a scientific journal, including a large normal school, with classes in zoölogy, geology, and botany; the Museum of the American Institute, of which one of them is custodian; and surroundings of excellent collecting-grounds. Such enterprises as this are evidence of a living love for science, and help to stimulate and extend it.

Aims and Methods of the Teaching of Physics. By Professor Charles K. Wead. Washington: Government Printing-Office. Pp. 158.

The author of this paper was commissioned by the Commissioner of Education to draw up a set of inquiries respecting the teaching of physics, send them to teachers, and collate and discuss the answers which should be received. The questions related to various points respecting the expediency of the teaching, the prominence and extent that should be given to it, and the method in which it should be done. Answers were received from seventy-two teachers in normal and secondary schools and colleges and universities, and other persons experienced in educational work, and are here given and reviewed. To these is added information from other countries. This is followed by an attempt to discover that consistent scheme of physics study which is favored by the majority of the contributors.

PUBLICATIONS RECEIVED.

Wintering Bees. By A. J. Cook. Agricultural College of Michigan. Pp. 6.

Impounding the Nile Floods. London: The Bedford Press. Pp. 6, with Map.

Pittsburg and Western Pennsylvania. Issued by the Pittsburg Chamber of Commerce. Pp. 128. With Map.

Something about Natural Gas. By George H. Thurston. Pittsburg. Pp. 32.

Franklin Institute, Philadelphia. Lecture Programme. 1885-'86.

Insanity of the Past, pp. 8; Report on Cerebro-Spinal Pathology, pp. 18; Forty Years of Cerebro-Spinal Pathology, pp. 16. All by Dr. Daniel Clark. Toronto, Ont.

American Economic Association. Constitution, etc. Richard T. Ely, Secretary. Baltimore, Md. Pp. 16.

The Climatic Treatment of Phthisis. By Harold Williams, M. D. Pp. 19.

Diana. New York: Burnz & Co. Pp. 56.

Sensory Aphasia. By Morton Prince, M. D. Boston. Pp. 14.

Studies from the Biological Laboratory of Johns Hopkins University. Baltimore: N. Murray. Pp. 24. Price, 30 cents a number. $3 a volume.

Moral and Material Progress contrasted. By Lester F. Ward. Washington: Judd & Detweiler. Pp. 16.

Syllabus of the Instruction in Biology. By Delos Fall. Albion, Mich. Pp. 24.

United States Government Publications. Monthly Catalogues, Nos. 7 and 8. Washington: J. H. Hickox. Pp. 20 each.

Juarez and Cesar Cantú. Refutation of Charges preferred by the Italian Historian. Official edition. Mexico: Government Printing-Office. Pp. 55.

Remarkables protubérances solaires (Remarkable Solar Protuberances), pp. 3; La planète Saturne en 1885 (The Planet Saturn in 1885), pp. 4; Observation d'une essaim de corpuscules noirs passant devant le soleil (Observation of a Swarm of Black Corpuscles passing in Front of the Sun), pp. 8; Murs énigmatiques observés à la surface de la lune (Enigmatical Walls observed on the Surface of the Moon), pp. 4; Sur la structure intime de l'enveloppe solaire (On the Intimate Structure of the Solar Envelope), pp. 29. With Plates. All by E. L. Trouvelot. Paris.

Distribution of the Reserve Material of Plants in Relation to Disease. By D. P. Penhallow. Pp. 10.

The Preparatory Schools and the Modern Language Equivalent for the Greek. By Charles E. Fay, Tufts College. Pp. 16.

Addresses at the Complimentary Dinner to Benjamin Apthorp Gould. Lynn, Mass.: Thomas P. Nichols. Pp. 40.

The Lick Observatory, Mount Hamilton, California. By David P. Todd. Pp 24.

Extensions of Certain Theorems of Clifford and of Cayley in the Geometry of N Dimensions. By E. H. Moore, Jr. Pp. 8.

Main Drainage and Water-Supply of Chicago. Report of Committee of Citizens' Association. J. C. Ambler, Secretary. Pp. 32.

The Relations between the Theromorphous Reptiles and the Monotreme Mammalia, pp. 12; and Various Geological and Paleontological Notes. By E. D. Cope. Philadelphia.

Aim and Method of the Rōmaji Kai, or Roman Alphabet Association of Japan. Tokio: Imperial Printing-Office. Pp. 28.

Pounding and Polishing Rice in England and Germany, pp. 10; The Licorice-Plant, pp. 20. (United States Consular Reports.) Washington: Government Printing-Office.

Report on Sanitary Improvement Bonds of

Jacksonville, Fla. R. N. Ellis, Superintendent. Pp. 45.

A Year's Scientific Progress in Nervous and Mental Diseases. By L. A. Merriam, M. D. Omaha, Neb. Pp. 7.

Value and Management of Government Timber-Lands, etc. Pp. 47. Agricultural Colleges and Experiment Stations; Convention Proceedings. Pp. 136. (Special Reports, Department of Agriculture.) Washington: Government Printing-Office.

Notes on Fruits, Vegetables, and Ornamental Trees and Shrubs. By L. H. Bailey, Jr., Agricultural College of Michigan. Pp. 11.

Study out of School-Hours. By L. M. Parish, Independence, Iowa. Pp. 6.

Lighting and Seating School-Houses. By L. F. Andrews, Des Moines, Iowa. Pp. 45.

Sanitary Science and Public Hygiene, pp. 9. Over-pressure in Schools, pp. 11. By W. S. Robertson, M. D., Muscatine, Iowa.

Evolution and Religion. Eight Sermons. By Henry Ward Beecher. New York: Fords, Howard & Hulbert. Pp. 145.

On the Temperature of the Surface of the Moon. By S. P. Langley, F. W. Very, and J. E. Keeler. Pp. 32, with Plate.

Architectural Studies. Store-Fronts and Interior Details. Edited by F. A. Wright. New York: William T. Comstock. Twelve Plates. $4.

Milk Analysis and Infant Feeding. By Arthur V. Meigs, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 102. $1.

A Guide to Sanitary House-Inspection. By William Paul Gerhard, C. E. New York: John Wiley & Sons. Pp. 145. $1.25.

Protectionism. By William Graham Sumner. New York: Henry Holt & Co. Pp. 172.

Elizabeth, or the Exiles of Siberia. From the French of Mme. Sophie Cottin. New York: William S. Gottsberger. Pp. 149.

Twenty Years with the Insane. By Daniel Putnam. Detroit: John MacFarlane. Pp. 175. 75 cents.

Lectures on the Principles of House Drainage. By J. Pickering Putnam. Boston: Ticknor & Co. Pp. 125.

Louis Agassiz: his Life and Correspondence. Edited by Elizabeth Cary Agassiz. Boston: Houghton, Mifflin & Co. 2 vols., pp. 792. $4.

The Last Meeting. By Brander Matthews. New York: Charles Scribner's Sons. Pp. 268. $1.

Mind-Culture on a Material Basis. By Sarah Elizabeth Titcomb. Boston: Cupples, Upham & Co. Pp. 288.

Rudder Grange. By Frank R. Stockton. New York: Charles Scribner's Sons. Pp. 322.

The German Verb-Drill. By Adolphe Dreyspring. New York: D. Appleton & Co. Pp. 276. $1.50.

Marvels of Animal Life. By Charles Frederick Holder. New York: Charles Scribner's Sons. Pp. 240. $2.

The Commonwealth of Georgia. Part I. The Country. By J. F. Henderson, Commissioner of Agriculture, Atlanta. Pp. 379. $1.

Miscellanies. By C. C. Merriam. Rochester, N. Y.: Judson J. Withall. Pp. 342, with Photographic Plates.

The Blood Covenant: A Primitive Rite and its Bearings on Scripture. By H. Clay Trumbull, D. D. New York: Charles Scribner's Sons. Pp. 350. $2.

Methods of Research in Microscopical Anatomy and Embryology. By Charles Otis Whitman. Boston: S. E. Cassino & Co. Pp. 255. $3.

Report on Forestry. Prepared by Nathaniel H. Egleston. Vol IV. 1884. Washington: Government Printing-Office. Pp. 421.

The Boys' and Girls' Pliny. By John S. White. New York and London: G. P. Putnam's Sons. Pp. 356. $3.

Fourth Annual Report of the United States Geological Survey. 1882, 1883. By J. W. Powell, Director. Washington: Government Printing-Office. Pp. 473.

POPULAR MISCELLANY.

The American Forestry Congress.—The American Forestry Congress held an interesting session in Boston in September. About a hundred members were present, who, by their own enthusiasm and by the reports they were able to make of the growth of interest in the subject, testified to the healthy progress which the cause of the protection and renewal of the woods is making in this country. Arbor-day is now observed as a festival in fifteen States, in a manner which well shows that the public are gradually coming into an appreciation of the sentiment which it typifies. Forest commissioners or commissions have been appointed by a number of States. Professor B. G. Northrup described the experiment of Mr. H. G. Russell, of East Greenwich, Rhode Island, in cultivating coniferous and deciduous trees upon a tract of two hundred acres along the shores of Narragansett Bay, sixty acres of which was a barren "sand blow," where every one said no trees could be made to grow. His method was to protect the trees and fix the sand by brush until the trees (which were set out) could take care of themselves. A resident stated that land on Cape Cod, which was a drug at twenty-five or fifty cents an acre twenty-five years ago, was now, in consequence of the growth of trees upon it, worth twenty dollars an acre, and desirable for residences. Mr. Fernow, corresponding secretary, read a paper on "Lumber-Waste as a Fertilizer." It proposed a plan for the utilization of the brush, etc., left by the loggers, which is now nothing but material for starting forest-fires, by rending it up into fine shreds or shavings, and then using it as bedding for horses and cattle, after which it will become manure. Mr. Fernow presented facts which tend to show that such applications may be made with profit all around. The subject of forest-fires came under discussion, and statements were made respecting their preventability and showing that they do not cause so great a proportion of the damage suffered by the forests as the lumbermen pretend that they do. Mr. Coleman, Commissioner of Agriculture, proposed the appointment of a committee to draft suitable forestry bills to be made laws by the General and State governments, and to labor with legislative committees to secure attention to them.

Among the other special topics considered in the papers were "Facts in regard to the Present State of American Forestry: State of Forest Legislation in the United States," N. H. Egleston; "What have the Different States done in regard to their Forests?" J. S. Hicks; "What are the Requisites of an Effective Forest-Fire Legislation?" S. W. Powell; "Lumbering Interests—their Dependence on Systematic Forestry," J. E. Hobbs; "Trees as Educators," Professor Edward North; "Profits of Forest-Culture," B. P. Poore; "Need of a National Forest Policy," Hon. Warner Miller; "Profits of Forest-Culture: State of Forest Legislation in the State of New York," Hon. H. R. Low.

The History of a Game.—Mr. J. W. Crombie read a paper before the British Association on what he styled "A Game with a History"—hop-scotch. As children in their play generally imitated something they had observed to be done by their elders, and a game once introduced was handed down from generation to generation, many innocent-looking children's games concealed strange records of ancient ages and pagan times. The game of hop-scotch was one of considerable antiquity, having been known in England for more than two centuries, and it was played all over Europe under different names. Signor Pitré's solar explanation of its origin appeared improbable, for not only was the evidence in its favor extremely weak, but it would require the original number of divisions in the figure to have been twelve instead of seven, the number indicated by a considerable body of evidence. It would seem more probable that the game at one time represented the progress of the soul from earth to heaven through various intermediate states, the name given to the last court being most frequently paradise or an equivalent, such as crown or glory, while the names of the other courts corresponded with the eschatological ideas prevalent in the early days of Christianity. Some such game existed before Christianity, and the author considered it had been derived from several ancient games. Possibly the strange myths of the Labyrinths might have had something to do with hop-scotch, and a variety of the game played in England, under the name of "round hop-scotch," was almost identical with a game described by Pliny as being played by the boys of his day. The author believed that the early Christians adopted the general idea of the ancient game, but they not only converted it into an allegory of heaven, with Christian beliefs and Christian names, they Christianized the figure also. They abandoned the heathen labyrinth and replaced it by the form of the basilica, the early Christian church, dividing it into seven parts, as they believed heaven to be divided, and placing paradise, the inner sanctum of heaven, in the position of the altar, the inner sanctum of the early church.

The Indians of Mount Roraima.—Mr. E. F. Im Thurm read some notes, in the Anthropological Section of the British Association, on the red-men about Mount Roraima, in British Guiana. He had found them still in the stone age, but not in the extremely primitive condition he had anticipated. There was no other place in British Guiana where the stone age still subsisted. These Indians live in small conical huts clustered into villages, and including a church, where they imitated, without understanding, the religious services they had seen at some far-off mission. They were generally ugly, some even repulsive, but hospitable and kind, and the reception the speaker's party had met with could not be surpassed in courtesy in the most civilized community. They made stone implements of a remarkable kind, such as adzes and axes, but stones were more usually fashioned, by a process of rubbing, into imitations of fish and articles of ornament. Their games were very interesting, some of them being imitations of animals, and others a kind of rhythmic swinging to a slow chant. The isolation of tribes, and even that of families, was remarkable. It had been caused by the fact that most of the tribes seemed to have arrived from the West Indian Islands and the Orinoco, and to have followed one another to the interior, where each tribe took charge of a river, while almost impenetrable forests intervened between their settlements. In answer to a question, Mr. Im Thurm stated that, though stone implements were made, they were not used for any practical purpose, and that there was no trace of their having been used in any religious service. They were made as curiosities. He found no trace among the red-men of any acknowledgment of a higher power.

Origin of the Whale.—Professor Flower remarked, pertinently to a description by Dr. Struthers in the Biological Section of the British Association, of the Tay whale, that the whale carried its pedigree on its own body and in every part of its structure. It had been thought that mammals might have passed through an aquatic and marine stage before they came to the land. But observations of the anatomy of the whale showed that this could not have been the case. There could be no question whatever that the whale had been derived from a four-footed animal. It was a characteristic of a mammal to have a hairy covering. Whales were at one time thought to be an exception, but it was shown, in almost every one that had been examined, that at some period of its life it must have had a rudimentary covering, which was generally found in the neighborhood of the upper lip; that covering was functionless and often lost before birth. Another remarkable feature was the teeth. All these whales were furnished with a set of teeth, rudimentary but complete, and not characteristic of the fish, but of a more completely developed land mammal. These teeth entirely vanished at an early period, sometimes before birth; and they were entirely functionless.

Insect Habits.—Sir John Lubbock contributed to the recent meeting of the British Association a paper on some recent observations on the habits of ants, bees, and wasps. One of the most interesting points connected with the economy of ants was the manner in which they recognized their friends. Not only would the ants in any nest, however large, distinguish between their own companions and other ants belonging to the same species, but this had been shown to happen even after a separation of more than a year. Mr. McCook had thought the faculty was due to scent, but Sir John deduced reasons for believing it to be otherwise. As regarded the longevity of ants, he had two which he had kept ever since 1874. They were then full grown, and must therefore be twelve years old. They were both queens and continued to lay eggs, showing no signs of age, excepting, perhaps, that they were a little stiff in the joints. His experiments did not confirm the idea that these insects had any sense of direction, except perhaps in the same sense in which we might be said to have one. In continuation of previous experiments, Sir John had taken forty ants, fed them with honey, and put them down on a gravel path fifty yards from their nest. They wandered about in all directions, and it was obvious that they had no idea which was the right way home.

Prolongation of Local Anæsthesia.—The discovery has been made by Dr. J. Leonard Corning, of New York, that local anæsthesia produced by the subcutaneous injection of the hydrochlorate of cocaine may be prolonged by annulling the local circulation. The results of three experiments, described by Dr. Corning in the "New York Medical Journal," were to show, first, that simple arrest of the circulation in the part, shortly after injection of the anæsthetic, is sufficient to intensify and prolong the anæsthesia; second, that if the injection is made after exsanguination and compression, there is little diffusion of the anæsthetic, and consequently a commensurate diminution in the number of nerve-filaments exposed to the influence of the solution; and, third, that, if the injection is made a few moments before exsanguination and the application of the tourniquet, a sufficient amount of saturation of tissue is obtained to expose a large number of nerve-filaments to the influence of the anæsthetic; and yet, if the delay is not too long, there is no danger of diluting or dissipating the solution by the access of too much blood to such a degree as to weaken or nullify the anæsthetic influence. Since by this method the anæsthesia can be practically prolonged to an indefinite degree, repeated injections are no longer necessary for that purpose, and the object is attained by the use of comparatively small quantities of cocaine. Hence the danger of constitutional disturbances from overdosing is avoided. Dr. M. J. Roberts has applied the method suggested by Dr. Corning in operations occurring in his practice, with complete success, in cases of excavation of the condyles of the humerus; of an operation on the bones of the leg; and of excision of the hip-joint. In the last case the success was less perfect, on account of the operator having been obliged to use a solution of inferior strength, but was fairly satisfactory. Professor J. Williston and other surgeons of eminence have also used the method with complete success.

Living Encrinites.—The encrinites are among the most interesting of the animals that inhabit the great sea-depths. They formerly played very important parts among the marine fauna, and their remains are found in great masses in the rocks of all the earlier formations. Their shapes, always graceful, now resembling lilies, now palm-trees, were wonderfully varied during the primary and secondary periods. They were nearly always fixed to the ground, while, in modern seas, the echinoderms most like them, the *Comatulæ*, are free, and have forms resembling star-fish, but lighter and more elegant. Encrinites were regarded as extinct till in the middle of the eighteenth century a naval officer brought to Europe a specimen which had been fished up alive. A few years afterward, Guettard described to the French Academy of Sciences another specimen which, dried, is still preserved in the collection of the Museum of Natural History; and, at a later date, some encrinites from the Antilles were distributed among different museums and collections in Europe. But these animals were rare till the time of the American dredging expeditions under Louis Agassiz. It is now known that encrinites, while they are not so abundant as they were in the epoch when limestone-beds were formed out of them, are by no means rare in the deep seas; and zoölogists are in a position to tell geologists what manner of life they lived, and what was the structure of those organisms whose remains are found everywhere, and whose real character once appeared so hard to determine. The discoveries of Sars, in the northern seas, of Pourtales and Alexander Agassiz in the Antilles, and of the various English expeditions, have raised the number of known species of crinoids to thirty-two, which are divided among four families and six genera.

Geology at the American Association.—Professor Orton delivered an opening address in the Geological Section of the American Association, on "Problems in the Study of Coal; with a Sketch of Recent Progress in Geology." The recent discoveries of the pteraspidian type of fishes in the Onondaga group of Central Pennsylvania, and of scales and spines of fishes (*Onchus Clintoni*) in the iron sandstone of the Middle Clinton group of the same region, give to American formations the earliest examples of vertebrate life yet known. A living shark has been identified that proves to be so nearly allied to the *Cladodus* of carboniferous time that it would be doing but little violence to refer it to that genus. Three separate discoveries of Upper Silurian scorpions and a Middle Silurian cockroach carry the life of the earliest land animals a few steps further back than the records of the strata had before disclosed. Two species of pulmoniferous mollusks from the lower part of the carboniferous rocks of Nevada constitute the sole known representatives of that group in palæozoic time. Stratigraphical geology appears to be attaining a somewhat juster recognition than has hitherto prevailed; and the growing use of the microscope in geology is to be noted as one of the directions in which progress is apparent and marked. In the later stages and higher forms of vertebrate life, "American geology holds an easy and undisputed pre-eminence. Along the eastern slopes of the Rocky Mountains there are being disentombed the remnants of great faunas of cretaceous and tertiary time that are quite without parallel in the history of geology. While these faunas are remarkable for the great number and variety of the species and individuals, and also for the enormous size of some of their forms, it is in other directions that their highest interest lies. By their anomalous and altogether unexpected characters, by their strange combination and dissociation of peculiarities of structure, they throw a flood of light on the question of evolution, and give us a key to the development of the existing creation that, before their discovery, it was too much to expect we should ever possess." The most important service, Professor Orton further remarked, that has been rendered in the American field, is the recent mapping of the great moraine from the Atlantic border to Dakota. On "the unfinished problems relating to the geology and chemistry of coal," Professor Orton enumerated the four principal theories of the formation of coal-beds, inclining to favor the peat-bog theory of Lesquereux and Brongniart. In accounting for coal-fields—a succession of coal-beds separated by marine formations and inorganic sediments of sandstone and iron-ore—we have to seek an explanation of the regularity of the intervals, and are referred to Croll's theory of an astronomical cause. Various unsettled questions also appear on the chemical side; and, while much has been done, much remains to be done in the field of the microscopical structure of coal. These problems will probably all be solved, but when that is done, "out of these old carboniferous swamps, new questions, larger, deeper than any we now see, will perpetually arise to stimulate by their discovery and to reward by their solution that love of knowledge for its own sake which makes us men." Captain E. L. Corthell presented a paper, which was read at a general meeting, on the contractions of the earth's crust and surplusage in mountain-structure. New discoveries of fossils in the older strata of various regions were announced. Professor Henry S. Williams presented a paper on the comparative stratigraphy of the southern counties of New York and the adjoining counties of Pennsylvania, and Northern Ohio as far as Cleveland. Professor E. W. Claypole discussed the problem of the origin of the palæozoic sediments of Pennsylvania. Professor Lewis E. Hicks described the structure and relation of the Dakota group in Nebraska. Mr. G. K. Gilbert described an old shore-line of Lake Ontario, which he had traced half-way about its basin. Professor A. R. Crandall described some small volcanic dikes which have recently been discovered in Elliot County, Kentucky. Professor Orton described the gas and oil wells of Northwestern Ohio, in the region of which Findlay is the center, and whose sources of supply are in formations lower than any from which gas has been known before to issue. The flow of gas ranges in the various wells from 100,000 to 1,200,000 cubic feet per day. The petroleum is not very abundant, and is black, sulphurous, and of a gravity of about 35°. The formation whence the gas and oil issue is a porous magnesian limestone identified as Trenton. Professor A. C. Worthen described the quaternary deposits of Central and Southern Illinois as observed in cutting coal-mine shafts through them. The bed-rock surface is diversified by valleys much as the drift surface above, but with a different drainage system. At the bottom is a stratified clay, in part gravelly, which appears to be derived from the waste of the bed-rock. Above this is a forest-bed, which, though not a universal feature, is so widely spread as to make much of the well-water unfit for use. Over this lies a blue and yellow gravelly clay, with glaciated bowlders sometimes as large as two feet in diameter; and, finally, a few feet of loess, covered with a thin bed of fine clay.

Educational Museums. — Dr. Burt G. Wilder, addressing the Biological Section of the American Association on "Educational Museums of Vertebrates," maintained that every institution, of whatever grade, should have one. In selection quality is more important than quantity, and arrangement is usually more needed than acquisition. As a rule, each specimen should teach but one thing, and that thoroughly. The same form may, therefore, properly recur in several parts of the museum, to illustrate different parts or ideas. True economy consists in paying liberally for what is wanted, rather than in taking what is not wanted as a gift. "In addition to, or in place of, the three great series—

physiological, taxonomic, and geographical—which are commonly attempted in museums, but which it is rarely possible to complete, specimens representing an equal amount of time or money would have a higher educational value if divided among a considerable number of special series, each illustrating some morphological or teleological principle. . . . Instead of vainly attempting to obtain and exhibit all the species of all the groups, most educational museums would attain more satisfactory results by selecting the more interesting or instructive forms from all classes, and limiting their efforts to complete groups for a few, upon which, as well as upon a larger number, may be illustrated the principles of classification and of individual and geographical variation. Among special series other than systematic, are analogous forms and structures which are sometimes mistaken for one another, but are more readily discriminated when brought together. . . . Physiological series would contain the hibernating animals, those which are blind or nearly so, and such as are provided with scent-glands or tusks, and all poisonous vertebrates. A local collection should embrace all the animals of the vicinity, and will benefit the student, both as an example for him to follow or improve upon, and as exemplifying the laws of geographical distribution and the influence of environment. The local collection need not contain anatomical preparations, but should exhibit both sexes and all stages of growth—its mode of life, friends, and foes—so as to interest also the children, farmers, fishermen, hunters, and other residents of the neighborhood."

In a paper on the hybridization and cross-fertilization of plants, Professor E. L. Sturtevant, of the New York Agricultural Experiment Station, showed that in our common vegetables cross-fertilization tends toward atavism, or reversion to an ancestral form, rather than to a blending of the individual properties of the present plants.

In describing some of the habits of the musk-rat, Mr. A. W. Butler mentioned well-authenticated cases of the change of habits as a means of adapting itself to the changed conditions of life brought about by the presence of civilized man.

Mr. J. C. Arthur reported, as the result of his investigations of pear-blight, that sap from an infected tree when inoculated into a healthy tree, invariably produced the disease; that when cultures to the sixth generation of organisms were made with all precaution to prevent error, and healthy trees were inoculated with the pure culture of this sixth generation, the tree was stricken with blight, which started from the point of inoculation and gradually extended over the whole plant; and that, wherever there was a blight not produced by freezing, bacteria of this species were invariably present. Professor Bessey read a paper on the inflorescence of the dodder.

The Section of Histology and Microscopy was discontinued, at the request of its members.

The Native Tribes of Alaska.—Mr. W. H. Dall's address to the Anthropological Section of the American Association was on "The Native Tribes of Alaska." Passing by the details in it which are chiefly of interest to specialists, we are informed that the tribal limits of the western Innuit, geographically considered, are very mutable, and constantly changing in small details. This arises from the fact that the geographical group which we have called a tribe among the Innuit is not a political organization headed by a chief or chiefs, but simply a geographical aggregation of people who have by possession obtained certain *de facto* rights of hunting, fishing, etc., over a certain area. The jealousy of adjacent groups keeps the imaginary boundary-line pretty well defined, through fear of reprisals should it be violated, but under the influence of the whites, with their trading-posts, the boundaries are becoming violable with impunity, and are falling into oblivion. Hence the geographical names distinguishing the groups are ceasing to have any serious significance. The degree of civilization which the Aleuts have attained is very promising. The people are not scattered over the archipelago except in their hunting-parties. Notwithstanding the nominal division into groups, they are practically as much one people as those of two adjacent English counties. The Rev. Mr. Dorsey gave an account of the peculiarities of the language spoken at the Siletz Indian agency, in Oregon, the population of which is made up of a consolidation of more than twenty tribes. The Indians are all more or less civilized, some of them taking newspapers, are very polite to strangers, and in many respects resemble the Ainos. In their language, the verb varies with the position of the object. They can not say "that man," but must say "that man walking," or sitting, or standing, etc. There are three sets of cardinal numbers, human, inhuman, and inanimate. All their villages have local names, as "the people of the ash-trees," "the people by the hill," "the people of the cañon," etc. A man must marry a woman from another village, and his children belong to the village of their father. They will not mention the names of the wild-cat, field-mouse, and some other animals, before their children, lest they bring sickness and death upon them. Five is the mystic number among them.

Miss A. C. Fletcher described the sacred war-tent of the Omahas, in which the sacred and ritual objects are stored. These objects are held in great reverence, and are under a special keeper. Among them is the sacred shell, a large *Unio*, which is contained in several leathern pouches, one within the other, and in which are placed strips of the inner bark of the cedar, and a scalp. In the tent are also the sacred wolf-skin, and two bundles covered with tanned skins. One of the bundles contains bird-skins; the other contains various deadly poisons. There are besides a staff of cedar and one of iron-wood, a small pipe-stem, two war-pipes, tobacco, and a scalp. The sacred shell must never touch the ground, for, if it should, a devouring fire would come from it. If any one but the keeper touches any of the objects, he will be afflicted with grievous sores, but the evil may be averted by going through certain ritual ablutions. All of these objects have been given, with the consent of the chiefs, to the Peabody Museum of Archæology.

The "Flight" of Flying-Fish.—The debate goes on as to whether flying-fish actually fly or only appear to fly, under an impulse which they have received while still in the water. One of the most authoritative opinions that has been expressed on the subject is probably that of Professor Möbius, of Kiel, who declares that "flying-fish are incapable of flying, for the simple reason that the muscles of their pectoral fins are not large enough to bear the weight of their body aloft in the air." The average weight of the muscles doing this work in birds is one sixth that of the whole body, and that of bats one thirteenth, while that of flying-fishes is only one thirty-second. The impulse to the propulsion of the flying-fish is delivered while they are still in the water, by the powerful masses of muscles on both sides of their body, which are of much greater breadth than in the case of the herring or any other fish of their own size. The visible flickering of the fins is only a vibration akin tc the flapping of a sail.

NOTES.

An extensive copper region is known to exist in Texas, running westward of Red River, from the line of the Indian Territory through several counties. The Grand Belt mines, fifty miles from Harrold, in Wilberger County, are operated by a company which owns claims for sixty-five miles along the ore-belt, and along which about sixty openings have been made, of an average depth of seven or eight feet. The ore is found principally in shallow pockets, and at the main point of taking out is said to average about fifty-four or fifty-five per cent of metallic copper.

In section A of the American Association, Professor Newton read a paper on "The Effect of Small Bodies passing near a Planet upon the Planet's Velocity"; Professor Harkness, of the U. S. Naval Observatory, on the flexure of transit instruments; Professor Hough, of the Dearborn Observatory, Chicago, presented a description of some improvements recently introduced in the printing chronograph devised by him. Professor J. Burkitt Webb described a new method of using polar co-ordinates; Mr. C. H. Rockwell, of Tarrytown, New York, presented some results of his observations for time and latitude, with a new instrument called the *almucantar*, which promises to be a very valuable addition to scientific apparatus.

M. Guillemin has formed a number of alloys of cobalt and copper. They are all red, have a fine fracture, and are much more tenacious than copper—even as high as from fifty to one hundred per cent more so, according to the proportion of cobalt. Five per cent of cobalt is enough to give an alloy of great resistance.

In the Geological Section of the British Association, Mr. H. Johnston Lavis presented the report of the committee for the investigation of the volcanic phenomena of Vesuvius. Its work had been interfered with by various circumstances growing out of the prevalence of cholera in Naples, but a careful record had been kept of daily observations of the variations in the activity of the volcano, and photographs had been taken of all important changes of the crater-plane and in the cone of eruption.

After a very interesting vice-presidential address on the phosphorescence of marine animals, Dr. W. B. Carpenter remarked, in the Biological Section of the British Association, that disciples of evolution were straining points to make it appear that the luminosity was of particular use and was propagated and increased by natural selection. He thought it was a great pity to strain that argument too far. It would be much better to abstain from more than mere speculation in regard to the use of this remarkable endowment.

Professor J. G. McKendrick described at Aberdeen some experiments he had made in the exposure of microphytes contained in meat to extremely low temperatures. The results showed that we might take organic fluids and expose them to the temperature of 120° below zero Fahrenheit for at least a hundred hours, and that then, after they had been placed in a higher temperature, fermentation and putrefaction would go on in the ordinary way. These facts destroyed any hope of a practical result being obtained from sterilization by cold.

Dr. B. Croumbie Brown reported in the Geographical Section of the British Association concerning his visit to the Forest School of Spain, one of the objects of which school was to insure that not a drop of water found its way to the sea without doing its best for the country. Spain was now convinced of the importance of scientific forestry, and of the function of forests in affecting the distribution and quantity of the rainfall, and was doing its best to conserve and replenish them.

The Emperor of Russia has conferred the golden honorary medal of the Empire upon Messrs. Alvan Clark & Sons, of Cambridge, Massachusetts, in acknowledgment of the excellent performances of the great object-glass furnished by them for the observatory at Pulkowa. This is the second award of the medal that has been made by the present emperor.

OBITUARY NOTES.

The death is announced of M. Breton des Champs, a French mathematician and scientific writer, who was best known from the part he took, a few years ago, in exposing the forgery of the letter alleged to be by Sir Isaac Newton which was sold to M. Chasles.

The death is announced of M. Edmond Boissier, an eminent French botanist. His career in science began in 1837, when he traveled in Spain, in preparation for his work on the botany of that country, which was published from 1839 to 1845. He afterward botanically explored various parts of Southeastern Europe and Asia Minor. His great work was the "Flora Orientalis," which was published from 1867 to 1881. He was engaged upon the supplements to this book at the time of his death. He was also author of a number of smaller works and monographs, among which was a series on the *Euphorbiæ*.

Walter Weldon, a distinguished English chemist, died September 21st, in the fifty-third year of his age. He was the inventor of the "Weldon process" for the regeneration of the manganese peroxide used in the generation of chlorine, by the aid of which the production of bleaching-powders has been vastly facilitated, with a great saving of expense in manufacturing processes. For this he received the grand medal of the French Société d'Encouragement, in presenting which Professor Dumas congratulated him on "having cheapened every sheet of paper and every yard of calico made in the world." He was engaged at the time of his illness in studying processes for producing hydrochloric acid from calcium chloride.

Mr. John Muirhead, the inventor of the Muirhead galvanic battery, which has served as a model for most of the existing batteries, has recently died, at the age of seventy-eight years.

Dr. H. W. Reichardt, Professor of Botany in the University of Vienna, died by suicide in August last, in the fiftieth year of his age. He contributed many articles on botany to the scientific journals of his country, chiefly to the "Journal of the Vienna Academy of Sciences." His last undertaking, a catalogue of the Imperial Botanical Cabinet, of which he was keeper, remains unfinished.

Dr. Albert Fitz, who has published some noteworthy researches in fermentation, died at Strasburg on the 11th of May.

Dr. Karl Julius Andrae, Professor of Mineralogy and Paleontology in the University of Bonn, died May 8th, in his sixty-ninth year.

Ludwig Freiherr von Hohenbühl, or Heufler von Rosen, an Austrian botanist, whose specialty was the cryptogams, died on the 9th of June, sixty-sveen years old.

FRANCIS TREVELYAN BUCKLAND.

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INOCULATION AGAINST HYDROPHOBIA.*

By M. LOUIS PASTEUR.

THE prevention of rabies, as I have described it, in my own name and the names of my collaborators, in previous notes, certainly constitutes a real progress in the study of that malady, a progress which was, however, more scientific than practical. Its application was precarious. Of twenty dogs that I had then treated, I could not assert that I had made more than fifteen or sixteen proof against rabies.

It was expedient, on the other hand, to finish the treatment by a final exceedingly virulent inoculation, with virus of control, in order to confirm and strengthen the refractory state. Finally, prudence made it necessary to keep the dogs under observation for a longer time than the period of incubation of the disease produced by the direct inoculation of the last virus; and it thus required an interval not less, perhaps, than three or four months to be assured of a fully refractory condition. These necessities considerably limited the application of the method. The method, also, did not accommodate itself readily to contingencies, which were always immediate, growing out of the accidental and sudden character of the bites of rabid animals. It was therefore necessary to obtain, if possible, a more rapid method, and one more capable of giving a security which might be considered perfect over dogs. Besides, how, before reaching that stage of progress, could we venture to make an experiment on man?

After almost innumerable experiments I obtained a preventive method, practical and prompt, of which sufficiently numerous and assured successes have been gained upon dogs to give me confidence in its general applicability to all animals, and to man himself.

* A paper read in the French Academy of Sciences, October 26, 1885.

This method is based essentially upon the following facts:

Inoculation of a rabbit, by trepanning, under the *dura mater*, with the poisonous marrow of a mad dog, always gives rabies to the animal after a mean period of incubation of about fifteen days. If the virus is passed from this first rabbit to a second, from this one to a third, and so on, by the same method of inoculation, there is shortly manifested a more and more marked tendency toward a shortening of the period of incubation in the rabbits successively inoculated. After from twenty to twenty-five passages from rabbit to rabbit, we arrive at a period of incubation of eight days, which is maintained during a new series of from twenty to twenty-five passages. Then we have a period of incubation of seven days, which occurs with striking regularity during a new series of passages rising to the ninetieth. At least that is the number I have now reached without having hardly yet observed a tendency to a slight further shortening of the period.

The experiments of this character, which I began in November, 1882, have already been continued for three years without the series having been interrupted, or without my having used any other virus than that from rabbits which successively died rabid. Nothing, therefore, is more easy than to have at one's disposition, during considerable intervals of time, a virus of perfect purity, always identical, or nearly so. This is the practical point of the method.

The marrows of these rabbits are infected with rabies of constant virulence in their whole extent. If we detach from them pieces a few centimetres long, taking the greatest possible precautions to insure their purity, and suspend them in dry air, the virulence of the rabies in them will slowly pass away, till it is quite extinguished. The duration of the process varies somewhat with the thickness of the marrow, but depends chiefly on the exterior temperature: the lower the temperature the longer the virulence lasts. These results constitute the scientific point of the method.*

These facts being substantiated, we have the following method of making a dog, within a reasonably short time, proof against rabies.

In a series of flasks, the air of which is kept dry by pieces of potash in the bottom, we suspend each day a piece of freshly infected marrow from a rabbit that has died of rabies, developed after seven days of incubation. Every day, at the same time, we inoculate under the skin of a dog a Pravaz syringeful of sterilized broth, in which has been soaked a small piece of one of the marrows we are keeping in desiccation, beginning with one of those which we have prepared several days before our operation is performed, so as to be sure that it is not of full strength. On that subject we have informed ourselves by previous experiments. We operate in the same manner on the following days

* If the infected marrow is protected from the air, and is kept moist in carbonic acid, the virulence will last, for several months at least, without change in intensity, provided it be guarded against the attack of microbes from without.

with more recent marrows, separated from one another by, say, two days of age, till we come at last to a very recent one, which has been in the flask for only one or two days. The dog is then found to be made proof against rabies. We can inoculate him under the skin, or even, by trepanning, under the surface of the brain, without the disease showing itself.

By the application of this method I had succeeded in getting fifty dogs, of various ages and races, proof against rabies without having had a single failure, when, on the 6th of July last, three persons from Alsace unexpectedly presented themselves at my laboratory: Theodore Vone, a grocer of Meissengott, near Schelstadt, who had been bitten in the arm on the 4th of July by his own dog, become mad; Joseph Meister, nine years of age, who had been bitten by the same dog at eight o'clock in the morning of the same day, and who, thrown to the ground by the dog, bore the marks of numerous bites on his hand, legs, and thighs, some of them so deep as to make walking hard for him. The more serious wounds had been cauterized only twelve hours after the accident, or at eight o'clock in the evening of the same day, with phenic acid, by Dr. Weber, of Villé; the third person, who had not been bitten, was the mother of Joseph Meister.

At the autopsy of the dog, which had been killed by its master, we found its stomach filled with hay, straw, and pieces of wood. It was certainly mad. Joseph Meister had been picked up from under it covered with froth and blood. M. Vone had marked bruises on his arms, but he assured me that the dog's teeth had not gone through his shirt. As he had nothing to fear, I told him he might go back to Alsace the same day, and he did so; but I kept little Meister and his mother.

The weekly meeting of the Academy of Sciences took place on the 6th of July. I saw our associate, Dr. Vulpian, there, and told him what had passed. He and Dr. Grancher, professor in the École de Médecine, had the kindness to come and see little Joseph Meister at once, and ascertain his condition and the number of his wounds, of which there were no less than fourteen. The opinion of these two physicians was that, in consequence of the severity and number of the bites upon him, Joseph Meister was almost certain to have hydrophobia. I then informed them of the new results which I had obtained in the study of rabies since the address I had delivered at Copenhagen a year previously. The death of this child seeming inevitable, I decided, not without considerable and deep anxiety, as you may imagine, to try upon him the method with which I had had constant success on dogs.

It is true that my fifty dogs had not been bitten before I found them to have been made proof against rabies. But I felt that I might dismiss all anxiety on this point, because I had already obtained a similar condition on a large number of dogs after they had been bitten.

Thus, on the 6th of July, at eight o'clock in the evening, sixty hours after he had been bitten on the 4th, in the presence of Drs. Vulpian and Grancher, we inoculated under a crease made in the skin of the hypochondrium of little Meister a half-syringe Pravaz of marrow of a rabbit that had died of rabies on the 21st of June, which had been kept since that time, or for fifteen days, in a flask of dry air.

New inoculations were made, always in the hypochroudres, under conditions of which a table is here given :

A HALF-SYRINGE PRAVAZ.

July	7,	9 A. M.,	marrow of	June	23,	14	days old.
"	7,	6 P. M.,	"	"	25,	12	"
"	8,	9 A. M.,	"	"	27,	11	"
"	8,	6 P. M.,	"	"	29,	9	"
"	9,	11 A. M.,	"	July	1,	8	"
"	10,	11 A. M.,	"	"	3,	7	"
"	11,	11 A. M.,	"	"	5,	6	"
"	12,	11 A. M.,	"	"	7,	5	"
"	13,	11 A. M.,	"	"	9,	4	"
"	14,	11 A. M.,	"	"	11,	3	"
"	15,	11 A. M.,	"	"	13,	2	"
"	16,	11 A. M.,	"	"	15,	1	day old.

I thus made the number of inoculations thirteen, and the number of days of treatment ten. I would say, furthermore, that a smaller number of inoculations would have been sufficient. But it is easily conceivable that in this first trial I should have acted with particular caution.

We also inoculated, by trepanning, two new rabbits with each of the several marrows employed, in order to test their states of virulence. The observations on these rabbits permit me to assert that the marrows used on the 6th, 7th, 8th, 9th, and 10th of July were not virulent, for they did not make the rabbits mad. Those of the 11th, 12th, 14th, 15th, and 16th of July were all virulent, in proportion as the marrow was fresher. Rabies declared itself after seven days of incubation in the rabbits of the 15th and 16th of July ; after eight days in those of the 12th and 14th ; and after fifteen days in those of the 11th of July.

I had thus in the last days inoculated Joseph Meister with the most virulent virus, that of the dog strengthened by several passages from rabbits to rabbits ; it was a virus that gave rabies after seven days of incubation to these animals, after eight or ten days to dogs. I was justified in venturing on this experiment by what had taken place with the fifty dogs of which I have spoken. When the state of immunity is reached, we can, without inconvenience, inoculate with the most virulent virus, and in any quantity ; and it has seemed to me that this had no other effect than further to confirm the condition of refractoriness against rabies.

Joseph Meister, then, has escaped, not only the rabies which his bites would have developed, but also that with which I inoculated him in order to confirm the immunity secured by the treatment—a more virulent rabies than that of the mad dog. The final extremely virulent inoculation had also the advantage of putting a term to the duration of the apprehensions we might entertain as to the consequences of the bites. If rabies was to break out, it would declare itself more speedily with a more virulent virus than that of the bites. From the middle of August I regarded the future of the health of Joseph Meister with confidence; and now, after three months and three weeks have passed since the accident, his health leaves nothing to be desired.

What interpretation shall we give to the new method which I have just described for preventing rabies after being bitten? I do not intend to consider this question in full to-day; but will limit myself to a few preliminary details, such as may help to comprehend the significance of the experiments which I prosecuted for the purpose of directing attention to the best of the possible interpretations.

Recurring to the methods of progressive attenuation of mortal viruses, and the prophylaxy that may be deduced from it, and the influence of the air in the attenuation being given on the other side, the first thought that occurs in trying to account for the effects is that the continued presence of rabies-infected marrows in contact with dry air progressively diminishes the intensity of their virulence till it is rendered *nil.* We are, therefore, led to believe that the prophylactic method under consideration rests upon the employment at first of virus without appreciable activity; then of weak viruses, and then of those of greater and greater virulence. I shall show, further on, that the facts are in disaccord with this view. I shall prove that the increase in the length of the periods of incubation of the rabies, communicated day after day to rabbits, as I have just said, to test the condition of virulence of our marrows, dried in contact with the air, is an effect of impoverishment in the quantity of the virus contained in the marrows, and not an effect of its impoverishment in virulence.

We may suppose that inoculation with a virus of virulence constantly identical in itself may lead to a condition proof against rabies by the process of employing very small but daily increasing quantities. This interpretation of the facts of the new method I have studied experimentally. . . .

I need not remark, in conclusion, that the most serious of the questions to be resolved now is perhaps that of the interval that should be observed between the time when the patient is bitten and that at which the treatment should be begun. In the case of Joseph Meister, the interval was two days and a half. But there is reason to suppose that it may sometimes be much longer.

On Tuesday last, the 20th of October, with the obliging assistance of Drs. Vulpian and Grancher, I began to treat a young man fifteen years old, who had been bitten six days before, in both hands, and whose condition was exceptionally grave.

The Academy will perhaps not be uninterested to hear the story of this young man's courage and presence of mind. He is a shepherd, named Jean-Baptiste Jupille, of Villers Farlay in the Jura, who, seeing a large dog of suspicious appearance rush at a group of six of his comrades, all younger than himself, sprang, whip in hand, in front of the animal. The dog seized Jupille by the left hand. Jupille then knocked the dog down, held it under himself, opened its jaw with his right hand to relieve his left, not without receiving several new bites, and then, with the thong of his whip tied up its muzzle, and, taking off one of his wooden shoes, dispatched the dog with it.

I shall promptly make known to the Academy the outcome of this new experiment.

[After the reading of M. Pasteur's paper, M. Vulpian remarked that the Academy should not be surprised to see one of the members of the Section of Medicine and Surgery take the floor to express the feelings of admiration which the communication had inspired in him. These feelings, he continued, "will be shared, I am convinced, by the whole medical profession. A remedy has at last been found for rabies, that terrible malady, against which all therapeutic measures had miscarried till now. M. Pasteur, who has had no precursor in this road, has been led, by a series of researches pursued uninterruptedly for years, to create a method of treatment that enables him surely to prevent the development of hydrophobia in a man who has been bitten by a mad dog: I say surely, because, after what I have seen in M. Pasteur's laboratory, I do not doubt the constant success of this treatment whenever it is put in practice in its completeness within a few days after the rabid bite has been inflicted. It becomes henceforth necessary to take into consideration the organization of a service for the treatment of hydrophobia by M. Pasteur's method. Every person bitten by a mad dog must be made able to enjoy the benefit of this great discovery, which affixes the seal to the glory of our illustrious associate, and which will shed an incomparable luster upon our dear country." On motion of Baron Larrey, a prize was proposed for young Jupille, in recognition of his bravery and devotion.

The President of the Academy, M. Bouley, expressed his full sympathy with the feelings which the Academy had just manifested by its applause. The date of the 26th of October, 1885, he said, would be marked as a great day among the festivals of French biology and medicine, and among the festivals of the medicine of the whole world. He would ask M. Pasteur whether, if, during the course of the preventive inoculations, an inoculated dog should bite a person or other animals in play, it would communicate rabies to them.

M. Pasteur replied that no experiments bearing on that point had yet been made.

On the 30th of October four other persons came from Arcachon to place themselves under M. Pasteur's care; so that, if success is gained in these cases also, six demonstrations will have been obtained from human subjects of the efficacy of the inoculation treatment. In an interview with a correspondent of the London "Times," M. Pasteur explained the philosophy of his treatment by stating that the virus acted very slowly, and, while he was making the body refractory to it by repeated inoculations, the virus deposited by the bite localized itself in the region of the wound. Whatever this region, that virus becomes digested during the year and a half which he has found by experiment the inoculation lasts, and will no longer exist in the body. As the propagation of the virus, which has always an ascending tendency and directs itself to the brain, takes place so slowly that the minimum of the total inoculation with it is thirty days, the whole question consists in inoculating the patient soon enough to prevent the propagation of the virus through the wound from spreading. In the case of Jupille, after the lapse of six days, the virus through the wounds had not yet left the hands. Consequently, it had not yet penetrated into any of the regions where its presence causes an outbreak of rabies. It will remain cooped up, till after some months it will have been digested and expelled.

There would be no need to dwell on the value of M. Pasteur's discovery, the "Times" suggestively remarks, "were it not for the strange perversity of those who will only see in the whole story a fresh ground for attacking physiological experiment. Such people, as we know from long experience, will lose all sight of the thousands and tens of thousands of animals whom M. Pasteur liberates from the curse, and of the multitudes of human beings freed from torture and death, when they think of the twenty or fifty rabbits in his laboratory. They forget, in the contemplation of a few cases of immediate suffering, the innumerable animals, friends of man, whom the discovery will set free. With these excellent people it is impossible to argue; but men whose sympathies are wider and whose sight is truer than theirs will unite in paying homage to the man who, if what he tells us is confirmed, has worked so patiently and so wisely to so noble and beneficent an end." —Editor of "The Popular Science Monthly."]

THE ORIGIN OF PRIMITIVE MONEY.

By HORATIO HALE.

THE European colonists who first became acquainted with the Indian tribes of the region now composing the United States and Canada were surprised and not a little interested when they found that these barbarous clans had, in one respect, a marked advantage over the great semi-civilized communities of Central and South America. The Mexicans and Peruvians were much addicted to traffic; but, like the Egyptians and Assyrians of early ages, they carried on their commerce without the use of money. The wampum of the Northern tribes was a real money, and as such it was destined to play an important part, for more than two centuries, in the intercourse between them and their white neighbors. Lawson, the historian of Carolina, writing nearly two hundred years ago, described in quaint but expressive terms, and with a satiric touch aimed at his own people, the place which this remarkable invention held in the social policy of the red-men. "This," he says, "is the money with which you may buy skins, furs, slaves, or anything the Indians have; it being the Mammon (as our money is to us) that entices and persuades them to do anything, and part with everything they possess, except," he adds significantly, "their children for slaves. . . . With this they buy off murders; and whatsoever a man may do that is ill, their wampum will quit him of, and make him, in their opinion, good and virtuous, though never so black before."

So common and wide-spread was the use of this money among the Indians, that the white colonists were fain to adopt it from them, and their laws for a time gave it an established value and circulation throughout New England and New York. In Massachusetts, as Dr. Ashbel Woodward tells us in his valuable monograph on "Wampum," it was made by statute, as early as 1637, a legal tender for any sum under twelvepence, at the rate of six beads for a penny; and in Connecticut it actually became a legal tender for any amount, being receivable for taxes at four beads for a penny. In Massachusetts the same valuation was adopted in 1640, four white beads or two blue beads being rated at a penny. In New York, for nearly half a century, owing to the scarcity of silver money, wampum was almost the only currency in use; and, though its circulation in ordinary traffic gradually ceased, it was still employed in the Indian trade down nearly to the middle of the present century.

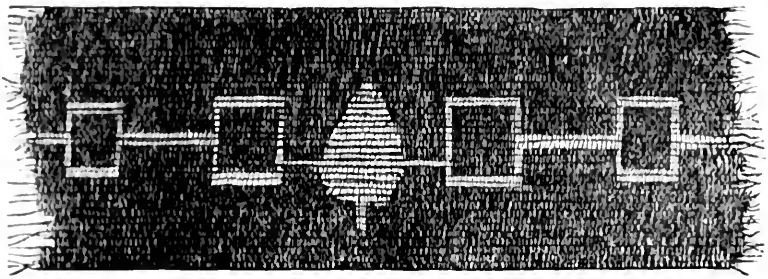
The material of this aboriginal currency may be described briefly as "shell-beads." It must not, however, be confounded with the cowries, or small shells, which are in use for a similar purpose in some parts of India and of Africa. It differed from them, in fact, as coined money differs from bullion. Wampum was a manufactured article. The great labor required to produce it was, indeed, the main element in its value. It was used in two forms. The least common, but apparently the earliest form, was that of disks, varying in size from that of an English sixpence, or rather, perhaps, from that of an American half-dime, to that of an English shilling, but somewhat thicker than these coins. One writer compares them, for size and thickness, to a peppermint-lozenge. These disks were perforated through the center, and commonly threaded upon a string. The other and more usual kind was of cylindrical shape, resembling the segment of a clay pipe-stem. These smaller beads had a diameter of about the eighth of an inch, and a length about twice or three times as great. Like the others, they were perforated, and usually strung upon a deer's sinew or a string of some description.

These disks, or cylinders, were of two colors, white and dark-purple, the latter generally styled black. They were made from sea-shells of several descriptions. The white beads were usually derived from various species of periwinkles or conchs. The purple sort were made chiefly from the large round clam, common on the Atlantic coast, and known by the Indian name of *quahaug*, and in science as *Venus mercenaria*. This mollusk has near the anterior end of the otherwise white inside of each valve a deep purple or brownish-black scar, indicating the point of muscular attachment, and known to fishermen as the "eye." This dark spot was broken out by the Indians to form their "black wampum," which, from its greater rarity, was always rated at a higher value than the white beads. Such, in brief, is the account given by Mr. Ernest Ingersoll, in his excellent article on "Wampum and its History," in the "American Naturalist" for May, 1883. The Indians who lived along the sea-coast were the principal manufacturers, and drove a brisk trade in this article with the tribes of the interior. Long Island, in particular, was a noted seat of this industry. It was the Potosi or California of the Northern Indians, and bore among them the name of Seawanhake, or "Land of Wampum." In traffic the money was computed sometimes by the number of beads, and sometimes by the length of the string.

The word *wampum* is of Algonkin origin. Its application to this money originated in a misconception of the early colonists. Properly it means simply "white." *Peage* or *peake*, we are told, was the name of the shell-beads, at least when strung. When loose, the term *sewan* (or, as pronounced by the Dutch colonists, *zeewand*) was applied to them. This term is said to mean simply "scattered," or "loose." A string of white beads, the most common currency, was called by the Indians *wampum-peak*, or "white strung-beads." The first portion of the compound word was caught by the settlers, and hence all money-beads became known among them as "wampum."

To break from the shell the fragment suitable for a bead, to rasp it on a stone to the proper circular or cylindrical shape, to polish it to an ivory smoothness, and then to pierce it with a drill-point of flint, was a tedious labor. It was this labor which, in great part, gave the wampum its value. This alone, however, would not have been sufficient, if the article had not held, in the social system of the Indians, a position which kept it always in demand. By their custom, handed down from time immemorial, it was essential that all great acts of state policy should be accompanied by the exhibition of wampum in some form. The messenger who summoned the chiefs of a tribe to a public meeting bore a string of wampum to authenticate his errand. The embassador, in proposing a treaty, laid down a string or belt of wampum at the close of every clause of his address. When the treaty was concluded, several belts were usually exchanged, by way of ratification. A belt of black wampum, formally delivered, was a declaration of war. A string of black wampum, borne by a runner, announced to all the villages of an Indian nation the death of a high chief; and, at his burial, belts and strings of wampum were deposited in his grave. At the great religious festival of the Iroquois, the "Sacrifice of the White Dog," the dead animal was enveloped in strings of wampum, which were burned with him. The belts and strings which accompanied the making of treaties and the framing of laws were kept as tribal records, and were brought forth on great occasions to be exhibited and explained to the people. The belts which commemorated the conclusion of the famous League of the Iroquois, framed by Hiawatha, Atotarho, and their associate chiefs, four hundred years ago, are still preserved on the Onondaga Reservation in the State of New York.

The belts, it should be added, were composed of short strings of wampum, containing from six to twenty-four beads each, laid side by side, and closely knotted together. The length of the string made the width of the belt, which varied from two to nine or ten inches, while its length varied from two to eight feet. The wider and longer the belt, the greater, of course, was its value, and the higher its significance as a pledge or memorial. Each belt usually had its special device, whose meaning was well understood. This device was wrought sometimes in white beads on a dark ground, sometimes in purple beads on a white ground. These symbols were genuine hieroglyphics, resembling the ancient pictorial figures in which the modern Chinese characters had their origin. In the Chinese script a parallelogram signifies an inclosure; it is the fence of a field. On an Iroquois belt a parallelogram denotes a town; for with them, in ancient times, the town was inclosed in a rectangular palisade. A lozenge-shaped figure represents a council; it is the Indian hearth, around which the councilors assembled. Oblique marks across a belt are the stamp and token of the Iroquois confederacy. They represent the rafters of the "long-house," to which the confederacy was likened. Others of these symbols are remembered, but a far greater number have been forgotten. Of the many hundreds, and indeed thousands, of belts which are known to have been fashioned during the last three centuries, each bearing its own device, less than fifty whose meaning can be explained are now known to exist.



Wampum Belt, commemorating the formation of the League of the "Five Nations" (Iroquois). The lozenge-shaped figure represents a native hearth, and indicates the Onondagas, the central nation who kept the council-fire of the confederacy. The square inclosures represent the other nations, the Mohawks and Oneidas on the right (or east), and the Cayugas and Senecas on the left. The connecting lines denote the "peace-path" opened between the nations by the League. The belt is about two feet long and ten inches wide.

Shell-beads exactly resembling the wampum are found in great abundance in the graves of the mound-builders, and sometimes, along with them, the large conch-shells from which such beads were made. Messrs. Squier and Davis, in their well-known work on the "Ancient Monuments of the Mississippi Valley," remark that "the number of beads found in the mounds is truly surprising; they may be counted in some instances by hundreds and thousands." They are described as resembling "sections cut from the ends of rods, or small cylinders, and subsequently more or less rounded upon the edge. Some are quite flat, and resemble the bone buttons of commerce; others are perfectly round. Their diameter varies from one fourth to three fourths of an inch. The size of the perforation is also variable, usually, however, about one tenth of an inch." No one doubts that these beads were used for the same purposes among this vanished people as among their successors. Dr. Daniel Wilson, in his admirable work on "Prehistoric Man," after referring to the fact that in the great Grave Creek Mound, evidently reared over the tomb of some notable personage, the shell-beads, such as constitute the wampum of the forest tribes, amounted to between three and four thousand, finds it "singularly consistent with the partial civilization of the ancient mound-builders that in such deposits we have the relics of sepulchral records, which constituted the scroll of fame of the illustrious dead, or copies of the national archives deposited with the great sachem, to whose wisdom or prowess the safety of his people had been due."

Indeed, when we consider that the tribes among whom the wampum currency and records were afterward used, in the particular form thus far described, were those which at first surrounded and afterward either conquered or absorbed this semi-civilized people, we might be tempted to conclude that the knowledge of this peculiar invention was a bequest to these modern tribes from their more advanced predecessors — just as some of the arts of Roman civilization were inherited by the barbarous conquerors of the empire. It is not impossible, nor indeed very improbable, that such may have been actually the case in this instance. But further inquiry shows that this system had a wider extent and probably a far remoter origin than this suggestion would explain.*

Crossing the Rocky Mountains, we find the shell-money in actual use among the tribes of the Pacific coast, down almost to our own day. Three kinds were known. In Northern California, in Oregon, and still farther north, a rare species of cylindrical univalve, the *Dentalium*, or tusk-shell, known in the Chinook "jargon" as the *hiqua*, or *ioqua*, was strung upon a string, and used as money. Its extreme rarity and its attractiveness as an ornament made, as with the pearl, its only claim to value. But farther south the genuine wampum, or disk-money, owing its value to the labor bestowed upon it, and to its importance in the social policy of the people, was in universal use. Full and interesting details on this subject are given by Mr. Stephen Powers in his instructive work on the "Tribes of California." Among the Nishinams and, as he believes, among all the tribes of Central and Southern California, the materials chiefly used are two species of sea-shell, found upon the coast. The most common is a thick white shell, the *Pachydesma crassatelloides*, from which is formed the money known as *hâwok*. This consists, he writes, "of circular disks or buttons, ranging from a quarter-inch to an inch in diameter, and varying in thickness with the shell. These are pierced in the center, and strung on strings made of the inner bark of the wild cotton, or milkweed (*Asclepias*), and either all the pieces on a string, or all in one section of it, are of the same size." The value of this money varies with the size of the disks. The larger pieces are rated at about twenty-five cents; the half-inch pieces at about half that value; and the smallest pieces at three or four cents, being usually rated by the string. "This," continues Mr. Powers, "may be called their silver, and is the great medium of all transactions; while the money answering to gold is made from varieties of the ear-shell (*Haliotis*) and is called *ullo*. They cut these shells with flints into oblong strips, from an inch to two inches in length, according to the curvature of the shell, and about a third as broad as they are long. Two holes are drilled near the narrow end of each piece, and they are thereby fastened to a string of the material above-named, hanging edge to edge. Ten pieces generally constitute a string, and the larger

* Those who desire to pursue this inquiry will find ample material in the valuable essay on "Art in Shell of the Ancient Americans," by Mr. W. H. Holmes, in the Second Annual Report of the Bureau of Ethnology.

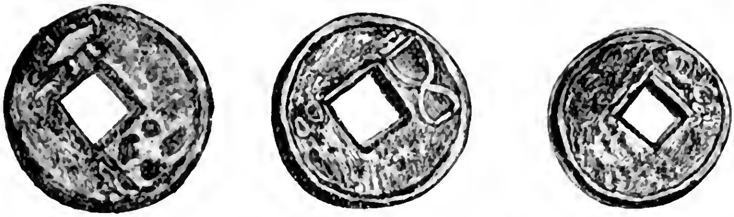
pieces rate at one dollar apiece—ten dollars a string; the smaller in proportion, or less, if they are not pretty. Being susceptible of a high polish, this money forms a beautiful ornament, and is worn for necklaces on gala-days. But as money it is rather too large and cumbersome, and the Indians generally seek to exchange it for the less brilliant and more useful *hawok*. The *ullo* may be considered rather as jewelry. The peculiar shape given to this *ullo*, or "gold-money," is deserving of notice, as will be seen hereafter.

Of the shell-money in general Mr. Powers remarks that "immense quantities of it were formerly in circulation among the Californian Indians, and the manufacture of it was large and constant, to replace the continual wastage which was caused by the sacrifice of so much upon the death of wealthy men, and by the propitiatory sacrifices performed by many tribes, especially those of the Coast Range." This use of shell-money in sacrifices and in funeral ceremonies is precisely the same that is made of the Eastern wampum. Like the shape of the oblong *ullo* money, this is a fact which will be found significant as we proceed. Mr. Powers continues: "From my own observations, which have not been limited, and from the statements of pioneers and the Indians themselves, I hesitate little to express the belief that every Indian in the State, in early days, possessed an average of at least one hundred dollars' worth of shell-money. This," adds the author, with a commercial precision which is both commendable and amusing, "would represent the value of about two women (though the Nishinams never actually bought their wives), or two grizzly-bear skins, or twenty-five cinnamon-bear skins, or about three average ponies. This may be considered a fair statement of the diffusion of wealth among them in their primitive condition."

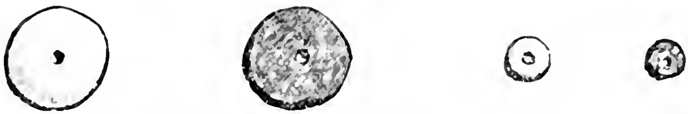
Thus it will be seen that shell-money of this peculiar character was in use over a wide space of North America, stretching from the Atlantic coast to the Pacific. The line along which it is found in the greatest abundance extends from New York and the Ohio Valley to Southern California in a direction somewhat south of west. If we continue this line in the same direction a little more than half-way across the Pacific, we arrive at the widely extended range of small islands, or congeries of island-groups, known in modern geography by the name of Micronesia. It fills a great part of the western half of the ocean north of the equator, and comprises the Radack and Ralick chains, the Kingsmill and Marshall groups, the Marian (or Ladrone) and Caroline Islands, the Pelews, Panape, Eap, and many smaller clusters and single islets. The well-known Loo-Choo islands form the stepping-stones, as it were, which lead from this vast archipelago to China and Japan. The natives of Micronesia are in about the same social stage as that which had been attained by the North American Indians when they were first known to the whites. In character, usages, and language they resemble to a certain extent the natives of the southern and eastern Pacific groups, which are included in the designation of Polynesia, but with some striking differences, which careful observers have ascribed, with great probability, to influences from Northeastern Asia. They are noted for their skill in navigation. They have well-rigged vessels exceeding sixty feet in length. They sail by the stars, and are accustomed to undertake long voyages.

The southernmost group of Micronesia, commonly known as the Kingsmill Islands, was visited and partly surveyed by the vessels of the Wilkes Exploring Expedition. During a very brief intercourse with the natives of the principal island, Taputeuea, large quantities of what was at first supposed to be an ornament were obtained from the natives, in exchange for other wares which they valued. This peculiar article was thus described, before its real character was understood: "It consists of a string of alternate wooden and shell beads, if this term may be applied to them. The 'beads' are in the shape of a sixpence with a hole through its center, or more nearly like the 'button-molds' of our dress-makers. They are made of fragments of cocoanut-shell and sea-shells, which are broken or cut nearly to the required shape, and then filed down together till they are smooth, even, and exactly of equal size. Those of sea-shell are white, and those of cocoanut black. They are strung alternately upon a small cord, and appear like a round flexible stick, half an inch in diameter, marked with alternate white and black rings." The beads, it appears, by the specimens preserved in the National Museum at Washington, were not all of one size. Besides the larger sort, resembling an English sixpence, there was a smaller description, of about half that size, and bearing when strung a surprising resemblance to a string of small wampum-beads, the only difference being that the Kingsmill Island disks are thinner than the proper wampum cylinders; but both in size and in thickness they resemble closely the smaller shell-money of California.

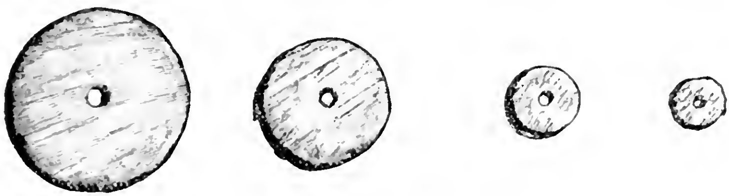
Further researches disclosed the true nature of this article, which, as it appeared, had been already studied and described by earlier voyagers at other islands of the Micronesian range. Adalbert von Chamisso, the naturalist who accompanied Admiral Kotzebue in his voyage around the world, was the first to make known its character and use. In speaking of the natives of the Ladrone Islands, now an extinct people, he remarks: "We have discovered among their antiquities something which seems to show a great advance made in civilization beyond any of the other islanders of the great ocean. We speak of the invention of money. . . . Disks of tortoise-shell, of the shape of button-molds, but thin as paper, and made extremely smooth by rubbing, are strung close together on a thick cord of twisted cocoanut-husk. The whole forms a flexible cylinder of the thickness of a finger, and several feet in length. These disks were in circulation as a medium of exchange, and only a few of the chiefs had the right to make and issue them." Some other facts are mentioned, which seem to indicate that



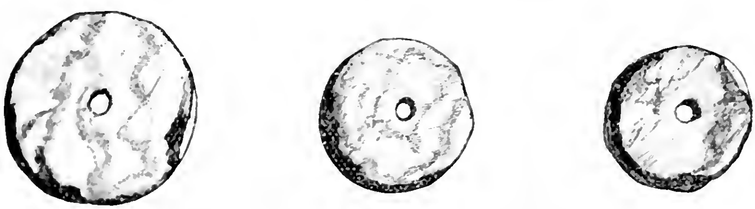
Chinese Copper Cash (ancient coins).



Kingsmill Island Shell-Money (white and black).



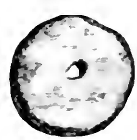
California Shell-Money (various sizes).



Shell-Disks from Illinois Mounds (ancient).

Ancient Wampum from Mounds.

Shell Disks from Huron Graves.



Large Wampum-Bead from Onondaga (recent).

Small Wampum-Beads, white and purple (recent).

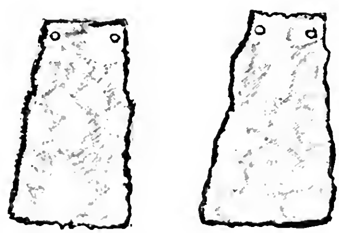
this tortoise-shell money had an important place in the social usages of the people.

This ancient currency of the Ladrones was evidently the same with the supposed bead-ornaments of the Kingsmill-Islanders, except that the latter use other shells instead of that of the tortoise. But, when the nature of the commodity became apparent, some noteworthy inferences were drawn from it. As has been already observed, some of the customs and much of the mythology of the Micronesian Islanders seem to have sprung from communication with Northeastern Asia. This peculiar currency takes us in the same direction. The most common Chinese coins, their copper *cash*, have a hole through the center, are strung upon strings, and disposed of by lengths. This money is in use in the Loo-Choo Islands, midway between Micronesia and China. In Beechey's voyage to the Pacific, speaking of the assertion hastily made by Captain Basil Hall, that the people of Loo-Choo have no money, he says, "Our meeting with this peasant, however, disclosed the truth, as he had a string of *cash* (small Chinese money) suspended to his girdle, in the manner adopted by the Chinese." In a foot-note he adds, "These coins, being of small value, are strung together in hundreds, and have a knot at each end, so that it is not necessary to count them."

But evidence still more remarkable is afforded by the very valuable "Monograph on the History of Money in China," which we owe to Mr. Alexander Del Mar, late of the United States Monetary Commission, and author of "A History of the Precious Metals," and other works. He mentions a curious fact recorded in the great Chinese encyclopædia of the Emperor Kang-he, who reigned in the early part of the last century. In this work it is stated that "in ancient times the money of China was of tortoise-shell." How far back we must go for these "ancient times" is sufficiently shown, as Mr. Del Mar remarks, by the fact that Kang-he himself possessed a cabinet of metallic coins dating from the reign of Yaou, B. C. 2347; and the Chinese annalists assert that metal coins were known in the time of Fuh-he, six hundred years before the date just recorded. From this it might seem that nearly five thousand years have elapsed since this tortoise-shell money was in common use in China. But, from what we know of the conservative temperament of the Chinese, it seems highly probable that many centuries must have passed before the clumsy and burdensome copper coins completely superseded the lighter and more convenient tortoise-shell disks and slips. Cowries are used to this day, along with metallic coins, in some parts of the East Indies. It is not unlikely that the total disappearance of the shell-money from the currency of China dates from the period when paper-money first came into use in that empire, which is said to have been in the reign of Woo-te, about one hundred and forty years before the Christian era.

Some very ancient Chinese coins are still preserved in the cabinets of antiquarians. Mr. Del Mar gives us pictures of several of these, the earliest being a coin of the Emperor Sung, dating 2257 years before Christ. These early coins are of various shapes, some being round with a square or round hole in the center, and some oblong with a hole at one end, evidently for stringing them. These oblong coins are spoken of as knife-shaped or bell-shaped, though the resemblances thus indicated are not very apparent. Dr. Tylor, whose careful research no evidence of this nature escapes, observes, in his standard work on "Anthropology," that "perhaps the earliest money may have been the Chinese little marked cubes of gold, and the pieces of copper in the shape of shirts and knives, as though intended to represent real shirts and knives." This is certainly an acute and striking suggestion; but we have to consider that the circular pieces, the most common of all, could hardly have been intended to represent any implement or other object of traffic. And when we refer to California, where, as has been seen, oblong pieces of shell, perforated at one end, were used as a variety of their currency, we are led to suppose that the early copper coins of the Chinese, both oblong and round, derived their shapes from imitation of the still earlier disks and strips of tortoise-shell which they superseded.

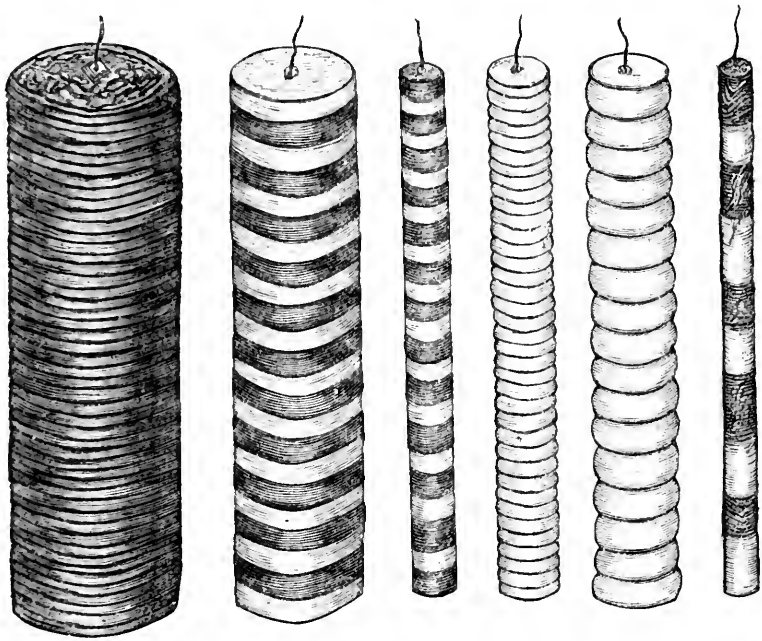
Ancient Chinese Coins.



Ullo.—Oblong Shell-Money of California.

A singular usage still prevailing in China seems to point back to a time when the ordinary money was made of some combustible material. "Mock-money," as it is called, is composed of tin-foil and paper, and this is burned in large quantities at funerals and in sacrifices to the gods. In California, as has been seen, the Indians were accustomed to burn their shell-money in a similar manner. The Eastern Indians buried wampum with their dead, and burned it in their sacrifices.

Thus shell-money of this peculiar description, composed of small circular disks, perforated and strung together, and used both as currency and also (so far as our information extends) in important public and religious ceremonies, has been traced from the eastern coast of North America westward across the continent to California, and thence through the Micronesian Archipelago to China. In no other parts of the world, except those situated along or near this line (as in some parts of Melanesia), has the use of this singular currency been known. It is possible, of course, that the custom may have originated independently in each of the four principal regions in which it existed—that is, in China, Micronesia, California, and Eastern North America. Few persons, however, will be inclined to doubt that the Micronesians received this invention from Eastern Asia; and, at the other end of the line, the transmission of the usage from one side of the Rocky Mountains to the other will seem equally probable. The only question will be as to its passage across the Pacific. The fact recorded by Dr. Wilson, in his work already quoted, that in 1833 a Japanese junk was wrecked on the coast of Oregon, and that some of her crew were sub-



1 2 3 4 5 6

1, Chinese Cash; 2 and 3, Kingsmill Island Shell-Money (large and small); 4, California Shell-Money (small); 5, Wampum (large), all white; 6, Wampum (small), white and purple.

sequently rescued from captivity among the Indians of that region, will show how easily this transmission might have been made. Nor is this the only instance known. Mr. Charles Wolcott Brooks, in his report on Japanese vessels wrecked in the North Pacific Ocean, read before the California Academy of Sciences in March, 1876, states that "one of these junks was wrecked on the Queen Charlotte Islands in 1831, and numerous others have been wrecked on other parts of the Northwest coast."

In certain respects the history of money bears a notable resemblance to the history of the alphabet, or rather of written speech. Nations have attained a high degree of civilization without a knowledge of either of these inventions; and each invention, when once known, has spread widely and rapidly through populations in very different stages of social progress. The alphabet, from a rude and vague beginning in Egypt, passed thence through Phœnicia to Greece, where it was perfected, and whence, in a few centuries, it was diffused to India on the one side and to Scandinavia and Britain on the other. In like manner coined money, vaguely beginning, as some suppose, with the scarabæi of Egypt, was brought to perfection in Greece, and thence spread through many civilized nations of Asia and among the semi-barbarous communities of Western Europe.

Both the art of writing and the use of money seem to have had an indigenous origin in China. The Chinese written character has spread through a large part of Eastern Asia. The Chinese currency, in its ancient form of shell-money, appears to have had a still wider diffusion. It has spread, apparently, through the islands of the North Pacific, and, either thence or directly from China or Japan, has been carried across the ocean to California, and so found its way eastward to the Ohio Valley and the Atlantic coast.

The fact, if it be a fact, that the Indians of the west coast of America received their monetary system from Eastern Asia or from the Pacific Islands, could not in itself be regarded as affording evidence that America was first peopled from that direction, just as the fact that the coinage of Bactria was derived from Greece would not indicate that the Bactrian population was of Grecian origin. All that we could infer would be some early intercourse, such as recent experience warrants us in supposing. A Chinese junk, or a large Micronesian *prao*, drifting to the Californian coast some three or four thousand years ago, would sufficiently explain the introduction of an art so easily learned as that of making and using perforated shell-disks for money.

PROGRESS IN TORNADO-PREDICTION.

By WILLIAM A. EDDY.

DURING the first part of 1884 the United States Signal Service began to pay special attention to the question of tornado-prediction. The development of the science was rapid under the active supervision of Lieutenant John P. Finley, having charge of that department of the service. It was found that the public interest in the question was wide-spread, and that, with the aid of voluntary reporters of tornado-phenomena, the possibility of saving life and property had begun to crystallize into a practical scheme. The power to verify predictions could only be obtained from two sources—from the press, and from tornado-reporters, who would voluntarily report the phenomena with some approach to scientific accuracy. The distinctions between a cyclone, five hundred or a thousand miles across the storm-center, a hurricane of more limited extent, and a tornado with a path only one thousand feet in width—all these must be properly classified before any system for the prediction of tornadoes could reach even approximately verified results. The number of tornadoes occurring in the region east of the Rocky Mountains was one hundred and seventy-two in 1884. The average is more than a hundred yearly. Whenever a tornado occurred, blanks specifying the questions to be asked and the method of investigation to be followed were at once sent to the postmaster or to the principal city or town officers in the vicinity of the scene of destruction, asking for facts, and requesting that the observer would kindly volunteer to continue a series of easy meteorological observations for the Signal Service, involving no more outlay of time than the reporter could conveniently spare. The result of this clever device was that the Signal-Office now has upon its books the addresses of more than fifteen hundred reporters in all parts of the country east of the Rocky Mountains, and especially in those States most frequently stricken with destructive tornadoes. Having thus organized a system whereby something like verification of tornado-predictions could be attained, Lieutenant Finley then divided the territory east of the Rocky Mountains into eighteen districts. He at once began making predictions in these districts, thus reaching a series of recorded averages whereby the results became more definite and local until the close of 1884 and the summer of 1885. The predictions in the latter year have become so effective that during the summer of 1886 it is hoped that, by means of signals, hundreds of lives and much valuable property will be saved.

The most striking examples of the knowledge attained regarding tornadoes are found by reference to the following statistics: During 1884, 3,228 predictions unfavorable to tornadoes were made, and of these, 3,201 were verified by reports sent in by tornado-reporters, who are instructed to carefully scan the newspapers as well as note the meteorological phenomena in a given neighborhood. When the conditions are unfavorable for the development of tornadoes, there are no unusual contrasts of temperature, the areas of warm and cold air are neither great nor well defined northward and southward, the winds are variable and not very strong, and the distribution of pressure is about normal.

When we consider that more than a hundred tornadoes occur annually, it follows that the successful prediction of safety for eighteen districts is a very satisfactory indication of the advance made by this science. The result is certainly practical and valuable, as with proper signals shown at telegraph-stations the inhabitants of Kansas, Missouri, and other States, can go to their work free from anxiety and not subject to false alarms on the appearance of every harmless thunder-storm. The predictions of safety are therefore particularly valuable in States in which tornadoes are frequent. When, however, we examine the statistics regarding the actual occurrence of tornadoes, we find the certainty lessened by the fact that the present limited resources of the Signal Service result in defective reports or in none at all from sparsely settled regions. Lieutenant Finley found that of thirty-eight predictions that tornadoes would occur, made in April and June, 1884, eighteen were verified, and that of nineteen predictions made in June and July, 1885, fifteen were generally verified. In all cases there were violent storms, either tornadoes, hurricanes, or hail. Owing to the extremely local nature of tornadoes, their tracks at times being only a mile or two in length and a few hundred feet in width, it is obvious that many predictions must apparently fail, owing to the fact that the effects are not seen until long afterward, or not at all where there are vast stretches of treeless prairie. It is doubtless true that this failure, due to the vagueness and unsatisfactory nature of the reports, induced Professor T. B. Maury to maintain, as late as 1882, that the prediction of a tornado was a triumph not yet attained by the science of meteorology, though doubtless he believed that success would be achieved at no very distant day. In order that the reader may see some of the reasons for expected progress in this science, let us examine, first, the methods in use by Lieutenant Finley for tracing the movement of air-masses, and second, the movement of the air-currents in the tornado-cloud, as seen by hundreds of observers.

It is well known that, owing to frequent telegraphic reports, the pressure, temperature, cloud-formation, extent, and movement of immense masses of air are permanently recorded. The conditions favorable to tornadoes are positive and noticeable. The areas of warm southerly and cold northerly winds are well defined, uniform, of large extent, and reach well to the north and south. High contrasts of humidity, abnormal variations in dew-point, the location of areas of barometric minima and maxima, with their lines of actual and probable progressive movement, and especially the velocity and direction of the wind, must be considered and mapped out on special charts. The temperatures are thrown out of their usual equilibrium and normal distribution over an extent at times of two thousand miles of territory. The cold air encroaches far into the Southern States, and the warm air of the South at such times may stream northward during a week or ten days. The movement in readjusting the equilibrium is like two pendulums thrown far apart which swing toward their common center with a force proportioned to the extent of their displacement. But this simple simile only fits the case roughly, because the questions of wind-direction, the location of the moving center of low pressure, and especially the inequality of the displacement of the air-masses north and south, make the problem very complex. Lieutenant Finley says that "the departure from normal conditions of temperature in case of tornado development is from 15° to 50°, but with this abnormal condition of temperature there must be abnormal conditions of humidity, abnormal conditions of pressure, of wind-direction, of cloud-formation and movement."

The most remarkable and interesting feature of the development of tornadoes is the fact that they nearly always form southeast of a moving center of low pressure, and their tracks, scattered here and there, conform closely to the progressive direction of the main storm. For example, on February 19, 1884, forty-four tornadoes occurred in Georgia, Alabama, and South Carolina, but principally in Georgia and Alabama. They developed at a distance of from five hundred to two thousand miles from a storm-center that moved across the northern part of the United States, beginning at the northern extremity of the Rocky Mountains in Montana, thence southeasterly through Dakota, Minnesota, and Wisconsin to Northern Illinois and Indiana, northward through Michigan across Lake Huron, disappearing north of Quebec. This sudden sharp turn of the storm-center southward into Illinois and Indiana seems to have relation to the unprecedentedly large number of tornadoes that developed not far from the South Atlantic coast, extending inland as far as Southern Illinois and Indiana. This southward lunge of a mass of cold, moist air seems to have caused the abnormal conditions of temperature and dew-point, and the high winds necessary to cause the most tremendous exhibition of destructive tornado-power ever recorded by the Signal Service. This invariable location southeast of the storm-center is one of the main peculiarities of tornado development upon which the predictions depend.

One of the best illustrations of the advance made in definiteness in prediction during 1885 occurred on August 3d, in the instance of the tornado at Camden, New Jersey, and at Philadelphia, Pennsylvania. In October, 1885, the writer had sent a short communication to the press of the country, advocating that tornado-signals of either safety or danger be shown during certain seasons of the year at all telegraph stations in States in which tornadoes are frequent. The gentlemen of the press had generally favored the scheme, and one of the editors wanted to know if the tornado at Camden had been predicted. It occurred at 3.20 P. M. (seventy-fifth meridian time), and was very destructive, involving a loss of about half a million dollars' worth of property. The chart used by Lieutenant Finley shows that tornadoes were predicted and their location marked upon the map for the States of Delaware, Southeastern Pennsylvania, and for New Jersey. The tornadoes actually occurred in these States about eight hours from the time of the prediction, which was made on the basis of the 7 A. M. (seventy-fifth meridian time) telegraphic reports. On that day heavy wind-storms were predicted for Vermont, New Hampshire, Massachusetts, New York, Northern New Jersey, and Eastern Pennsylvania. Nature carried out these predictions with as fair a degree of accuracy and with as definite a conformity to location as could be expected at the present primary stage of this science.

The accumulations of great quantities of evidence concerning tornadoes have revealed some interesting facts. It is supposed that certain localities in the Eastern States are entirely free from tornadoes, but an examination of Lieutenant Finley's record from 1794 to 1881 shows that they at times approach dangerously near the most unexpected localities. One occurred in New York city, July 13, 1859, and this fact has been further emphasized by the appearance of another at Westwood, New Jersey, October 4, 1885, only twenty-one miles above the city, and not far from the Hudson River. Of the six hundred tornadoes recorded from 1794 to 1881, sixty-two occurred in Kansas, fifty-three in Illinois, forty-three in Missouri, thirty-five in New York, thirty-three in Georgia, thirty-two in Iowa, twenty-eight in Ohio, twenty-five in Indiana, twenty-two in Minnesota, eighteen in North Carolina, eighteen in Pennsylvania, eighteen in Texas, eighteen in Tennessee, fourteen in South Carolina, fifteen in Michigan, fourteen in Alabama, fourteen in Nebraska, fourteen in Mississippi, ten in Louisiana, ten in Wisconsin, nine in Massachusetts, nine in Dakota, nine in Virginia, eight in Arkansas, eight in Maryland, five in Connecticut, six in Kentucky, five in Florida, five in New Hampshire, six in New Jersey, three in Maine, two in Arizona, two in Vermont, and one each in Colorado, California, Indian Territory, Nevada, New Mexico, Montana, Rhode Island, West Virginia, and Wyoming Territory. The above figures are defective, owing to the absence of records in the past, but it may be accepted as an undoubted fact, soon to be demonstrated by the more careful system of investigation to be carried on by an army of tornado-reporters, that the proportion of tornadoes in Kansas, Missouri, Iowa, and Wisconsin is much greater than shown. The real prevalence in these States, as compared with others, is better represented by the record of unusually destructive tornadoes. Of this class Kansas leads with twenty-five, Illinois follows with fifteen, then come Iowa and Missouri with twelve each. The Eastern States disappear from the list with the exception of Pennsylvania three and Connecticut one—the well-known destruction of life and property at Wallingford. Of the six hundred tornadoes, three hundred and four moved from southwest to northeast, and the remainder, with marvelously few exceptions, kept very close to that direction. So comparatively certain is this movement that the tornado-track can be escaped by running southeast, depending, of course, upon the direction from which the storm is seen. Northwest is not so safe a direction to take, because so many move northward, veering very slightly eastward. The length of the track varies from one to one hundred and fifty miles, and the average is thirty miles. The average width of the storm-path is one thousand and eighty-five feet, and the velocity of progression is about thirty miles an hour. The form of the cloud is almost invariabiy funnel-shaped, varied at times with that of the hour-glass, cone, and inverted funnel, modifications caused by different altitudes and velocities of air-currents. It is estimated that in the center of the funnel the air sometimes attains the enormous speed of two thousand miles an hour. The whirling movement is almost invariably in an opposite direction from that taken by the hands of a clock.

The weather-predictions of the Signal Service are distinct from the tornado-predictions, which involve local treatment that severely tests the science of meteorology. It is true the tornado region follows the usual storm-center along parallel lines, but at a distance of several hundred miles. The tornadoes develop far from the storm-center, and generally under conditions of partial sunshine and cloudiness and high humidity or excess of moisture. The relation of tornado-prediction to the usual weather-service is only in regard to details of temperature, wind-direction, dew-point, etc., as furnished by the general weather reports. The prediction of the movement of the usual storm-center is by no means so difficult as the attempt to even approximately locate the general region where a series of tornadoes will occur, because of the narrow track in which the destructive power is manifested. The officers of the Signal Service are careful to make no rash promises. While knowledge of the phenomena is not entirely complete, yet the advancement of the science is so marked and positive that tornadoes can be predicted for certain parts of States with a degree of average certainty that will, if carried out by the establishment of a system of signals in 1886, prove of very great value to the people. Already insurance companies have been enabled to take millions of dollars of tornado risks, and the more complete knowledge of the average danger for given localities will set the questions of premiums and rates of insurance upon a basis that will be profitable for the people as well as for the companies. The danger in localities will be established by averages, and the amount of precaution necessary will be known, and may be expressed in trustworthy percentages. This will economize expenditure both for insurance and tornado-retreats underground. The protection to life will be a very marked feature of the results attained. The approach of the tornado along its almost inevitable path, of from southwest to northeast, can be seen for fully an hour above the surface of a flat prairie, thus enabling people to get far beyond the reach of its narrow but fearfully destructive path. With this we close the question of the prediction of tornadoes for certain parts of States.

Let us now examine the closer prediction made by the trained observer or tornado-reporter, as he sees the tornado-cloud in process of formation. The question as to whether the furious movement of the clouds is forming the funnel-shape so much dreaded can only be decided by careful study of the sights and sounds described by hundreds of observers. A very important characteristic of tornado air-currents is that the disturbance begins in the upper air. In the "North American Review" for September, 1882, Professor T. B.

Maury, in an article entitled "Tornadoes and their Causes," attributes the peculiar movement of our tornadoes to an upper air-current, which at times has been seen to be "moving from the southwest at the rate of one hundred miles an hour." In addition to this, Lieutenant Finley's descriptions of the thirteen tornadoes that occurred in Kansas, May 29 and 30, 1879, give abundant evidence that the southwest air-current forces the contest. Innumerable descriptions show that the cloud in the northwest is heavy, black, and comparatively slow in its movement, until struck by a light, rather smoky, and more rapidly moving cloud from the southwest. Then the clouds rush to a common center, and there is a violent conflict of currents, driving clouds in every direction, up and down, round and round. Clouds like great sheets of white smoke dash about in a frightful manner, with such unnatural velocity that the observer is often panic-stricken, and flees to the nearest cellar for safety. Finally a black, threatening mass descends slowly toward the earth, whirling violently, but still manifesting confusion in form. This soon gives place to the peculiar funnel-like shape, with definite outline so well known. It appears intensely black, like coal-smoke issuing from a locomotive, and its trunk-like form sometimes has a wrenching, spiral motion, like a snake hung up by the head and writhing in agony. As white clouds approach and are drawn into the vortex, the funnel-shaped trunk sways like an elastic column. It sometimes rises, falls, and careens from side to side like a balloon. Branches and trunks of trees, rails, tree-tops, roofs, pieces of houses, straw, furniture, stoves, iron-work, lumber, and other *débris* are seen flying about in the central part of the cloud, but are gradually drawn upward and thrown out near the top, usually not until the storm has progressed a mile or two farther on from a given point. Dark masses of cloud are seen to shoot downward on either side of the funnel, to enter it just above the ground, and to apparently rush upward through the center and out at the top in a terrific manner. Sometimes the funnel pauses and whirls with apparently increased velocity, reducing everything to splinters, and leaving scarcely a vestige of a house or clump of trees, all being ground comparatively fine and carried away as chaff. At Westwood, New Jersey, October 4, 1885, fully three quarters of a school-house was carried away from the foundation. Its fragments were scattered along the storm's track for about half a mile, and the rest was seen no more. The people at Westwood describe the roar of the tornado as having a peculiar hollow, humming sound. It somewhat resembled the rumbling of cars, or the booming of the sea. The sound is indescribable and unlike any other in Nature. It is so loud that the falling of heavy trees against the side of a house and the crash of falling buildings are lost in the general roar. These facts attest the tremendous rapidity of the air-currents.

In addition to a downward movement of air, there is also a violent reactionary upward movement through the center of the funnel. This center is almost a vacuum surrounded by a cylindrical mass of air of great density and revolving force. Professor William M. Davis, of Harvard College, whose work, entitled "Whirlwinds, Cyclones, and Tornadoes," is well known for its merit and originality, maintains that the destructive power of a tornado is due to the rush of air along the earth's surface toward the vacuum center of the funnel. Some buildings have a stricken, pinched appearance at the top, as if the air had rushed under the edge of a huge cylinder, and swept upward with tremendous power. While it is true that the downward movement predominates, yet the upward movement in the center is equally marked. The iron grip of the tornado-funnel is relieved only by the escape of currents to the upper air through its center, and this again is doubtless due to the decrease of the contrasts of temperature between the opposing currents, thus gradually lessening the air-movement. In the Westwood tornado, when the funnel had gone about a mile northeast of the village, it became thinner, and the distance to the top of the revolving column did not seem more than one hundred feet. As its force still further weakened, it became only a shallow, whirling cloud of *débris*, six or seven feet above the ground, and about fifty feet in width. These facts present a problem of the relation of air-pressures in which we may look for destructive action in proportion to the height of the column of revolving air.

Lieutenant Finley's interesting studies will soon be of great service to the people. The advancement of the science of meteorology, as well as of other sciences, has always been made through those whose energy in the examination of these subjects has been manifested as an intrinsic liking, regardless of personal gain, a characteristic pointed out long ago by Jean Paul Richter, and reaffirmed by Emerson as the true aim of the scholar. It has been thought that the time will come when greater numbers of men of leisure and means will become steady workers along paths of unprofitable public usefulness. The people look for science to come to their rescue regarding certain evils in politics or in commerce, in over-legislation, in physical and mental life, and in the destruction of life and property by the elements. It does not follow that the service will be rewarded, yet the control or anticipation of any form of destructive action in Nature is a benefit that will live in the annals of the race for many a century.

THE VARIETIES OF THE HUMAN SPECIES.*

By Professor WILLIAM H. FLOWER, F. R. S.

THE most ordinary observation is sufficient to demonstrate the fact that certain groups of men are strongly marked from others by definite characters common to all members of the group, and transmitted regularly to their descendants by the laws of inheritance. The Chinaman and the negro, the native of Patagonia and the Andaman-Islander, are as distinct from each other structurally as are many of the so-called species of any natural group of animals. Indeed, it may be said with truth that their differences are greater than those which mark the groups called genera by many naturalists of the present day. Nevertheless, the difficulty of parceling out all the individuals composing the human species into certain definite groups, and of saying of each man that he belongs to one of other of such groups, is insuperable. No such classification has ever, or indeed, can ever, be obtained. There is not one of the most characteristic, most extreme forms, like those I have just named, from which transitions can not be traced by almost imperceptible gradations to any of the other equally characteristic, equally extreme, forms. Indeed, a large proportion of mankind is made up, not of extreme or typical, but of more or less generalized or intermediate, forms, the relative numbers of which are continually increasing as the long-existing isolation of nations and races breaks down under the ever-extending intercommunication characteristic of the period in which we dwell.

The difficulties of framing a natural classification of man, or one which really represents the relationship of the various minor groups to each other, are well exemplified by a study of the numerous attempts which have been made from the time of Linnæus and Blumenbach onward. Even in the first step of establishing certain primary groups of equivalent rank there has been no accord. The number of such groups has been most variously estimated by different writers from two up to sixty, or more, although it is important to note that there has always been a tendency to revert to the four primitive types sketched out by Linnæus—the European, Asiatic, African, and American—expanded into five by Blumenbach by the addition of the Malay, and reduced by Cuvier to three by the suppression of the last two. After a perfectly independent study of the subject, extending over many years, I can not resist the conclusion, so often arrived at by various anthropologists, and so often abandoned for some more complex system, that the primitive man, whatever he may have been, has in the course of ages divaricated into three extreme types, represented by the

* From the President's Anniversary Address to the Anthropological Institute of Great Britain and Ireland, January 27, 1885.

Caucasian of Europe, the Mongolian of Asia, and the Ethiopian of Africa, and that all existing individuals of the species can be ranged around these types, or somewhere or other between them. Large numbers are doubtless the descendants of direct crosses in varying proportions between well-established extreme forms; for, notwithstanding opposite views formerly held by some authors on this subject, there is now abundant evidence of the wholesale production of new races in this way. Others may be the descendants of the primitive stock, before the strongly marked existing distinctions had taken place, and therefore present, though from a different cause from the last, equally generalized characters. In these cases it can only be by most carefully examining and balancing all characters however minute, and finding out in what direction the preponderance lies, that a place can be assigned to them. It can not be too often insisted on that the various groups of mankind, owing to their probable unity of origin, the great variability of individuals, and the possibility of all degrees of intermixture of races at remote or recent periods of the history of the species, have so much in common that it is extremely difficult to find distinctive characters capable of strict definition by which they may be differentiated. It is more by the preponderance of certain characters in a large number of members of a group, than by the exclusive or even constant possession of these characters in each of its members, that the group as a whole must be characterized.

Bearing these principles in mind, we may endeavor to formulate, as far as they have as yet been worked out, the distinctive features of the typical members of each of the three great divisions, and then show into what subordinate groups each of them seems to be divided.

To begin with the Ethiopian, Negroid, or Melanian, or "black" type. It is characterized by a dark, often nearly black, complexion; black hair, of the kind called "frizzly," or, incorrectly, "woolly," i. e., each hair being closely rolled up upon itself, a condition always associated with a more or less flattened or elliptical transverse section; a moderate or scanty development of beard; an almost invariably dolichocephalic skull; small and moderately retreating malar bones (mesopic face*); a very broad and flat nose, platyrhine in the skeleton; moderate or low orbits; prominent eyes; thick, everted lips; prognathous jaws; large teeth (macrodont); a narrow pelvis (index in the male 90 to 100); a long fore-arm (humero-radial index 80), and certain other proportions of the body and limbs which are being gradually worked out and reduced to numerical expression as material for so doing accumulates.

The most characteristic examples of the second great type, the Mongolian or Xanthous or "yellow," have a yellow or brownish complexion; coarse, straight hair, without any tendency to curl, and nearly

* Oldfield Thomas, in a paper read before the Anthropological Institute, January 13, 1885.

round in section, on all other parts of the surface except the scalp, scanty and late in appearing; a skull of variable form, mostly mesocephalic (though extremes both of dolichocephaly and brachycephaly are found in certain groups of this type); a broad and flat face, with prominent anteriorly projecting malar bones (platyopic face); nose small, mesorhine or leptarhine; orbits high and round, with very little development of glabella or supraciliary ridges; eyes sunken, and with the aperture between the lids narrow; in the most typical members of the group with a vertical fold of skin over the inner canthus, and with the outer angle slightly elevated; jaws mesognathous; teeth of moderate size (mesodont); the proportions of the limbs and form of the pelvis have yet to be worked out, the results at present obtained showing great diversity among different individuals of what appear to be well-marked races of the group, but this is perhaps due to the insufficient number of individuals as yet examined with accuracy.

The last type, which, for want of a better name, I still call by that which has the priority, Caucasian, or "white," has usually a light-complexioned skin (although in some, in so far aberrant cases, it is as dark as in the negroes); hair fair or black, soft, straight, or wavy, in section intermediate between the flattened and cylindrical form; beard fully developed; form of cranium various, mostly mesocephalic; malar bones retreating; face narrow and projecting in the middle line (pro-opic); orbits moderate; nose narrow and prominent (leptorhine); jaws orthognathous; teeth small (microdont); pelvis broad (pelvic index of male 80); fore-arm short, relatively to humerus (humero-radial index 74).

In endeavoring further to divide up into minor groups the numerous and variously modified individuals which cluster around one or other of these great types, a process quite necessary for many practical or descriptive purposes, the distinctions afforded by the study of physical characters are often so slight that it becomes necessary to take other considerations into account, among which geographical distribution and language hold an important place.

I. The Ethiopian or Negroid races may be primarily divided as follows:

A. African or typical negroes—inhabitants of all the central portion of the African Continent, from the Atlantic on the west to the Indian Ocean on the east, greatly mixed all along their northern frontier with Hamitic and Semitic Melanochroi, a mixture which, taking place in various proportions, and under varied conditions, has given rise to many of the numerous races and tribes inhabiting the Soudan.

A branch of the African negroes are the Bantu—distinguished chiefly, if not entirely, by the structure of their language. Physically indistinguishable from the other negroes where they come in contact in the equatorial regions of Africa, the Southern Bantu, or Caffres, as they are generally called, show a marked modification of type, being lighter in color, having a larger cranial capacity, less marked prognathism, and smaller teeth. Some of these changes may possibly be due to crossing into the next race.

B. The Hottentots and Bushmen form a very distinct modification of the negro race. They formerly inhabited a much larger district than at present; but, encroached upon by the Bantu from the north, and the Dutch and English from the south, they are now greatly diminished, and indeed threatened with extinction. The Hottentots especially are much mixed with other races, and, under the influence of a civilization which has done little to improve their moral condition, they have lost most of their distinctive peculiarities. When pure-bred they are of moderate stature, have a yellowish-brown complexion, with very frizzly hair, which, being less abundant than that of the ordinary negro, has the appearance of growing in separate tufts. The forehead and chin are narrow, and the cheek-bones wide, giving a lozenge-shape to the whole face. The nose is very flat, and the lips prominent. In their anatomical peculiarities, and almost everything except size, the Bushmen agree with the Hottentots; they have, however, some special characters, for while they are the most platyrhine of races, the prognathism so characteristic of the negro type is nearly absent. This, however, may be the retention of an infantile character so often found in races of diminutive stature, as it is in all the smaller species of a natural group of animals. The cranium of a Bushman, taken altogether, is one of the best marked of any race, and could not be mistaken for that of any other race. Their relation to the Hottentots, however, appears to be that of a stunted and outcast branch, living the lives of the most degraded of savages among the rocky caves and mountains of the land of which the comparatively civilized and pastoral Hottentots inhabited the plains.

Perhaps the Negrillos of Hamy, certain diminutive, round-headed people of Central and Western Equatorial Africa, may represent a distinct branch of the negro race, but their numbers are few, and they are very much mixed with the true negroes in the districts in which they are found. They form the only exceptions to the general dolichocephaly of the African branch of the negro race.

C. *Oceanic Negroes* or *Melanesians.*—These include the Papuans of New Guinea and the majority of the inhabitants of the islands of the Western Pacific, and form also a substratum of the population, greatly mixed with other races, of regions extending far beyond the present center of their area of distribution.

They are represented, in what may be called a hypertypical form, by the extremely dolichocephalic Kai Colos, or mountaineers of the interior of the Feejee Islands, although the coast population of the same group have lost their distinctive characters by crossing. In many parts of New Guinea and the great chain of islands extending eastward and southward ending with New Caledonia, they are found in a more or less pure condition, especially in the interior and more inaccessible portions of the islands, almost each of which shows special modifications of the type recognizable in details of structure. Taken altogether their chief physical distinction from the African negroes lies in the fact that the glabella and supra-orbital ridges are generally well developed in the males, whereas in Africans this region is usually smooth and flat. The nose, also, especially in the northern part of their geographical range, New Guinea, and the neighboring islands, is narrower (often mosorhine) and prominent. The cranium is generally higher and narrower. It is, however, possible to find African and Melanesian skulls quite alike in essential characters.

The now extinct inhabitants of Tasmania are probably pure but aberrant members of the Melanesian group, which have undergone a modification from the original type, not by mixture with other races, but in consequence of long isolation, during which special characters have gradually developed. Lying completely out of the track of all civilization and commerce, even of the most primitive kind, they were little liable to be subject to the influence of any other race, and there is in fact nothing among their characters which could be accounted for in this way, as they are intensely, even exaggeratedly, Negroid in the form of nose, projection of mouth, and size of teeth, typically so in character of hair, and aberrant chiefly in width of skull in the parietal region. A cross with any of the Polynesian or Malay races sufficiently strong to produce this would, in all probability, have also left some traces on other parts of their organization.

On the other hand, in many parts of the Melanesian region there are distinct evidences of large admixture with Negrito, Malay, and Polynesian elements in varying proportions, producing numerous physical modifications. In many of the inhabitants of the great Island of New Guinea itself and of those lying around it this mixture can be traced. In the people of Micronesia in the north, and New Zealand in the south, though the Melanesian element is present, it is completely overlaid by the Polynesian, but there are probably few, if any, of the islands of the Pacific in which it does not form some factor in the composite character of the natives.

The inhabitants of the continent of Australia have long been a puzzle to ethnologists. Of Negroid complexion, features, and skeletal characters, yet without the characteristic frizzly hair, their position has been one of great difficulty to determine. They have, in fact, been a stumbling-block in the way of every system proposed. The solution, supported by many considerations too lengthy to enter into here, appears to lie in the supposition that they are not a distinct race at all, that is, not a homogeneous group formed by the gradual modification of one of the primitive stocks, but rather a cross between two already formed branches of these stocks. According to this view, Australia was originally peopled with frizzly-haired Melanesians, such as those which still do, or did till the recent European invasion, dwell in the smaller islands which surround the north, east, and southern portions of the continent, but that a strong infusion of some other race, probably a low form of Caucasian Melanochroi, such as that which still inhabits the interior of the southern parts of India, has spread throughout the land from the northwest, and produced a modification of the physical characters, especially of the hair. This influence did not extend across Bass's Strait into Tasmania, where, as just said, the Melanesian element remained in its purity. It is more strongly marked in the northern and central parts of Australia than on many portions of the southern and western coasts, where the lowness of type and more curly hair, sometimes closely approaching to frizzly, show a stronger retention of the Melanesian element. If the evidence should prove sufficiently strong to establish this view of the origin of the Australian natives, it will no longer be correct to speak of a primitive Australian, or even Australoid, race or type, or look for traces of the former existence of such a race anywhere out of their own land. Proof of the origin of such a race is, however, very difficult if not impossible to obtain, and I know nothing to exclude the possibility of the Australians being mainly the direct descendants of a very primitive human type, from which the frizzly-haired negroes may be an offset. This character of hair must be a specialization, for it seems very unlikely that it was the attribute of the common ancestors of the human race.

D. The fourth branch of the Negroid race consists of the diminutive, round-headed people called Negritos, still found in a pure or unmixed state in the Andaman Islands, and forming a substratum of the population, though now greatly mixed with invading races, especially Malays, in the Philippines, and many of the islands of the Indo-Malayan Archipelago, and perhaps of some parts of the southern portion of the mainland of Asia. They also probably contribute to the varied population of the great Island of Papua or New Guinea, where they appear to merge into the taller, longer-headed, and longer-nosed Melanesians proper. They show, in a very marked manner, some of the most striking anatomical peculiarities of the negro race, the frizzly hair, the proportions of the limbs, especially the humero-radial index, and the form of the pelvis; but they differ in many cranial and facial characters, both from the African negroes on the one hand, and the typical Oceanic negroes, or Melanesians, on the other, and form a very distinct and well-characterized group.

II. The principal groups that can be arranged around the Mongolian type are—

A. The Eskimo, who appear to be a branch of the typical North Asiatic Mongols, who in their wanderings northward and eastward across the American Continent, isolated almost as perfectly as an island population would be, hemmed in on one side by the eternal polar ice, and on the other by hostile tribes of American Indians, with which they rarely if ever mingled, have gradually developed characters most of which are strongly expressed modifications of those seen in their allies who still remain on the western side of Behring Strait. Every special characteristic which distinguishes a Japanese from the average of mankind is seen in the Eskimo in an exaggerated degree, so that there can be no doubt about their being derived from the same stock. It has also been shown that these special characteristics gradually increase from west to east, and are seen in their greatest perfection in the inhabitants of Greenland; at all events, in those where no crossing with the Danes has taken place. Such scanty remains as have yet been discovered of the early inhabitants of Europe present no structural affinities to the Eskimo, although it is not unlikely that similar external conditions may have led them to adopt similar modes of life. In fact, the Eskimo are such an intensely specialized race, perhaps the most specialized of any in existence, that it is probable that they are of comparatively late origin, and were not as a race contemporaries with the men whose rude flint tools found in our drifts excite so much interest and speculation as to the makers, who have been sometimes, though with little evidence to justify such an assumption, reputed to be the ancestors of the present inhabitants of the northernmost parts of America.

B. The typical Mongolian races constitute the present population of Northern and Central Asia. They are not very distinctly, but still conveniently for descriptive purposes, divided into two groups, the Northern and the Southern.

a. The former, or Mongolo-Altaic group, are united by the affinities of their language. These people, from the cradle of their race in the great central plateau of Asia, have at various times poured out their hordes upon the lands lying to the west, and have penetrated almost to the heart of Europe. The Finns, the Magyars, and the Turks, are each the descendants of one of these waves of incursion, but they have for so many generations intermingled with the peoples through whom they have passed in their migrations, or have found in the countries in which they have ultimately settled, that their original physical characters have been completely modified. Even the Lapps, that diminutive tribe of nomads inhabiting the most northern parts of Europe, supposed to be of Mongolian descent, show so little of the special attributes of that branch, that it is difficult to assign them a place in it in a classification based upon physical characters. The Japanese are said by their language to be allied rather to the Northern than to the following branch of the Mongolian stock.

b. The Southern Mongolian group, divided from the former chiefly by language and habits of life, includes the greater part of the population of China, Thibet, Burmah, and Siam.

C. The next great division of Mongoloid people is the Malay, subtypical, it is true, but to which an easy transition can be traced from the most characteristic members of the type.

D. The brown Polynesians, Malayo-Polynesians, Maforis, Sawaioris, or Kanakas, as they have been variously called, seen in their greatest purity in the Samoan, Tongan, and Eastern Polynesian Islands, are still more modified, and possess less of the characteristic Mongolian features; but still it is difficult to place them anywhere else in the system. The large infusion of the Melanesian element throughout the Pacific must never be forgotten in accounting for the characters of the people now inhabiting the islands, an element in many respects so diametrically opposite to the Mongolian, that it would materially alter the characters, especially of the hair and beard, which has been with many authors a stumbling-block to the affiliation of the Polynesian with the Mongol stock. The mixture is physically a fine one, and in some proportions produces a combination, as seen, for instance, in the Maories of New Zealand, which in all definable characters approaches quite as near, or nearer, to the Caucasian type, than to either of the stocks from which it may be presumably derived. This resemblance has led some writers to infer a real extension of the Caucasian element at some very early period with the Pacific Islands, and to look upon their inhabitants as the product of a mingling of all three great types of men. Though this is a very plausible theory, it rests on little actual proof, as the combination of Mongolo-Malayan and Melanesian characters in different degrees to the local variations certain to arise in communities so isolated from each other and exposed to such varied conditions as the inhabitants of the Pacific Islands would probably account for all the modifications observed among them.

E. The native population (before the changes wrought by the European conquest) of the great Continent of America, excluding the Eskimo, present, considering the vast extent of the country they inhabit and the great differences of climate and other surrounding conditions, a remarkable similarity of essential characters, with much diversity of detail.

The construction of the numerous American languages, of which as many as twelve hundred have been distinguished, is said to point to unity of origin, as, though widely different in many respects, they are all, or nearly all, constructed on the same general grammatical principle—that called *polysynthesis*—which differs from that of the languages of any of the Old World nations. The mental characteristics of all the American tribes have much that is in common; and the very different stages of culture to which they had attained at the time of the conquest, as that of the Incas and Aztecs, and the hunting or fishing tribes of the North and South, which have been quoted as evidence of diversities of race, were not greater than those between different nations of Europe, as Gauls and Germans on the one hand, and Greeks and Romans on the other, in the time of Julius Cæsar. Yet all these were Aryans, and in treating the Americans as one race it is not intended that they are more closely allied than the different Aryan people of Europe and Asia. The best argument that can be used for the unity of the American race—using the word in a broad sense—is the great difficulty of forming any natural divisions founded upon physical characters. The important character of the hair does not differ throughout the whole continent. It is always straight and lank, long and abundant on the scalp, but sparse elsewhere. The color of the skin is practically uniform, notwithstanding the enormous differences of climate under which many members of the group exist. In the features and cranium certain special modifications prevail in different districts, but the same forms appear at widely separated parts of the continent. I have examined skulls from Vancouver's Island, from Peru, and from Patagonia, which were almost undistinguishable from one another.

Naturalists who have admitted but four primary types of the human species have always found a difficulty with the Americans, hesitating between placing them with the Mongolian or so-called "yellow" races, or elevating them to the rank of a primary group. Cuvier does not seem to have been able to settle this point to his own satisfaction, and leaves it an open question. Although the large majority of Americans have in the special form of the nasal bones, leading to the characteristic high bridge of the nose of the living face, in the well-developed superciliary ridge and retreating forehead, characters which distinguish them from the typical Asiatic Mongol, in so many other respects they resemble them so much that, although admitting the difficulties of the case, I am inclined to include them as aberrant members of the Mongolian type. It is, however, quite open to any one adopting the Negro, Mongolian, and Caucasian as primary divisions, also placing the Americans apart as a fourth.

Now that the high antiquity of man in America, perhaps as high as that he has in Europe, has been discovered, the puzzling problem, from which part of the Old World the people of America have sprung, has lost its significance. It is quite as likely that the people of Asia may have been derived from America as the reverse. However this may be, the population of America had been, before the time of Columbus, practically isolated from the rest of the world, except at the extreme north. Such visits as those of the early Norsemen to the coasts of Greenland, Labrador, and Nova Scotia, or the possible accidental stranding of a canoe containing survivors of a voyage across the Pacific or the Atlantic, can have had no appreciable effect upon the characteristics of the people. It is difficult, therefore, to look upon the anomalous and special characters of the American people as the effects of crossing, as was suggested in the case of the Australians, a consideration which gives more weight to the view of treating them as a distinct primary division.

III. The Caucasian, or white division, according to my view, includes the two groups called by Professor Huxley Xanthochroi and Melanochroi, which, though differing in color of eyes and hair, agree so closely in all other anatomical characters, as far, at all events, as has at present been demonstrated, that it seems preferable to consider them as modifications of one great type than as primary divisions of the species.

Whatever their origin, they are now intimately blended, though in different proportions, throughout the whole of the region of the earth they inhabit; and it is to the rapid extension of both branches of this race that the great changes now taking place in the ethnology of the world are mainly due.

A. The Xanthochroi, or blonde type, with fair hair, eyes, and complexion, chiefly inhabit Northern Europe—Scandinavia, Scotland, and North Germany—but, much mixed with the next group, they extend as far as Northern Africa and Afghanistan. Their mixture with Mongoloid people in North Europe has given rise to the Lapps and Finns.

B. Melanochroi, with black hair and eyes, and skin of almost all shades from white to black. They comprise the great majority of the inhabitants of Southern Europe, Northern Africa, and Southwest Asia, and consist mainly of the Aryan, Semitic, and Hamitic families. The Dravidians of India, and probably the Ainos of Japan, the Maoutze of China, also belong to this race, which may have contributed something to the mixed character of some tribes of Indo-China and the Polynesian Islands, and, as before said, given at least the characters of the hair to the otherwise Negroid inhabitants of Australia. In Southern India they are probably mixed with a Negrito element, and in Africa, where their habitat becomes conterminous with that of the negroes, numerous cross-races have sprung up between them all along the frontier line. The ancient Egyptians were nearly pure Melanochroi, though often showing in their features traces of their frequent intermarriage with their Ethiopian neighbors to the south. The Copts and fellahs of modern Egypt are their little-changed descendants.

In offering this scheme of classification of the human species, I have not thought it necessary to compare it in detail with the numerous systems suggested by previous anthropologists. These will all be found in the general treatises on the subject. As I have remarked before, in its broad outlines it scarcely differs from that proposed by Cuvier nearly sixty years ago, and that the result of the enormous increase of our knowledge during that time having caused such little change is the best testimony to its being a truthful representation of the facts. Still, however, it can only be looked upon as an approximation. Whatever care be bestowed upon the arrangement of already acquired details, whatever judgment be shown in their due subordination one to another, the acquisition of new knowledge may at any time call for a complete or partial rearrangement of our system.

COMMUNAL SOCIETIES.

By CHARLES MORRIS.

IN the paper on "Neuter Insects," recently published in "The Popular Science Monthly,"* the argument on certain phases of animal evolution there presented was not offered as a complete one. For a full exposition of the development of ant and bee intelligence, this subject needs to be considered from another point of view, and the present paper is intended as, in a partial sense, a sequel to the one above named.

It is usual to divide animals, in respect to their habits of association, into two classes, the solitary and the social. The solitary animals comprise all those which form sexual combinations only, and the class embraces all those species of the smaller mammals and birds which flock together solely from the fact that they are very numerous, and seek food in the same localities, not from any association for mutual aid.

The social animals form true communities. They are banded together by certain common interests, and possess a principle of association beyond that of the sexual. They present the germinal condition of a political society. These comprise most of the large herbivora, which aggregate for purposes of common defense, in some cases stationing sentries for protection while feeding, and in others following certain acknowledged leaders. Instances of any such association are rare among carnivora, the wolves being the most marked example.

Yet in the social animals, as a rule, the common interests are few, and the links of association weak. Individuality largely persists, there is no idea of common property, and nearly or quite the only interest in common is that of attack or defense. Separated from these by a broad interval are some three or four animal tribes whose socialism is of so advanced a type that it fairly deserves to be indicated by a special name. These tribes comprise the ants, bees, and termites, among insects, and the beavers among mammals. Their conditions of association are so different from those prevailing in most other cases, that it seems proper to consider them as a separate class. I propose for them the title of *communal animals*, as most distinctive of their life-habits.

Instead of possessing a few links of combination, these animals have most or all of the relations of life in common. In ant and bee communities, for instance, individualism has vanished. All property is held in common, all labor is performed for the community, there are a common home, common stores, common duties, community alike in assault and defense, and it is difficult or impossible to detect any ant

* December, 1885.

or bee doing anything for itself alone, or performing any act which is not intended for the good of the community as a whole. Selfishness, so far as the home community is concerned, seems to have vanished, and labor and life are freely given for the good of this great whole, with no evident display of any thought of individual comfort or aggrandizement.

The communities of termites are communal in an equally complete sense, and seem to have utterly lost the selfish sentiment which is the ruling agency with solitary animals. With the beavers communalism has stopped somewhat short of this complete stage. They possess their dams and canals in common, and labor together in all the needs of out-door life. But they have not advanced to the stage of a common home, their habits rendering this impossible, or nearly so; and, though they seek food in common, each lodge lays up its own private stores. Yet their interests are so largely in common that they stand distinctly separate in this respect from the ordinary social vertebrates, and fairly belong to the communal class, in company with their insect analogues.

There is one further interesting and suggestive feature in these communal groups of animals, whose significance will be apparent when we come to consider the conditions of human communities. This is that they are family aggregates. The indefinite association of the social animals has become a strictly family association in the communal animals. This is not very clearly displayed in the beavers. Yet with them the inmates of each lodge probably belong to a single family, and form a group within the larger group. And the community as a whole may be descended from a single ancestor, like the members of the patriarchal family among men.

With the ants, bees, and termites this family association has gone much further, and each community constitutes a single family. Division of labor has proceeded to such an extent that the egg-bearing function is confined to one or a few members of the community, while all the sexual individuals beyond these perish. This principle has gone farthest with the bees, who permit but one female to develop for the use of each swarm, and who mercilessly destroy all the males, as soon as they become a burden on the community.

Thus it is evident that the conditions of communal life among animals can not fairly be claimed as merely advanced instances of socialism. They differ not only in regard to degree of community of interests, but also in displaying a new and distinct principle of association. The social group is a vague one, the communal a strictly defined one, which has gradually grown up in the midst of the older group and finally replaced it. Alike in ants, bees, and rodents, species exist in various stages of association, between the solitary and the communal, and could we trace all the steps of development we should undoubtedly perceive solitary animals gradually adopting social relations, and then family groups developing in the midst of the larger social groups, and acquiring special interests which render them finally hostile to other family groups. There can be but little question that the ants, termites, bees, and wasps, have passed through these various stages of association, and that the old social groups gradually broke up into minor family groups, which in turn have developed into extensive groups, combined on the principle of blood relationship.

This gradual evolution of the principle of association, beginning in the completely solitary or hermaphrodite tribes, and reaching its ultimate stage in the colonial or compound animals, of which we have a notable instance in the *Siphonophora*, or family compound of swimming polyps, in which the loss of individuality is complete, is a highly interesting phase of animal development, which we can not undertake to consider here as a whole. We may simply say that animals might be classified, from this point of view, as the truly solitary, the sexual, the social, the communal, and the colonial or compound.

The views above expressed lead directly to the consideration of primitive human societies, since these present a striking resemblance to those of the lower animals. The indications are, indeed, that the development of society everywhere follows one fixed course, and obeys one general law, and that human society has in no sense escaped this law, despite all the seeming irregularity of its development.

Man may properly be ranked with the ants, bees, and termites, as another instance of the communal animal, the beaver being his only vertebrate counterpart in this respect. Communalism probably did not exist with primitive man. He seems to have been originally a social animal, like the quadrumana, from whom it is assumed that he descended. Yet it is interesting to perceive that, at the opening of the historical period, the ancestors of all the present civilized races were in the communal stage of association, and under conditions which present a striking parallel to those of the lower tribes of communal animals.

Alike with the American Indians, the Mongolians and Semites of Asia, and the primitive Aryans, history opens with strongly declared instances of the communal type of association. The original social groups, with few interests in common, had been replaced by well-defined family groups, with nearly all interests in common. The ancient association vanished as this new association developed, and the family became the basis of all social organization. We might, had we space, consider at some length the evolution of this new condition of human society. It doubtless had its basis in that slowly growing energy of the marriage sentiment, whose development has been traced by several recent writers. The primitive weak sense of union between husband, wife, and children gradually grew into a strong bond of association, whose strength was added to by the possession of a separate family property, which increased in value with the development of society.

Thus in the heart of the old vague social group there grew up intimately associated family groups of increasing size and importance. The double link of property and blood-relationship rendered this association a strong one, and we seem to see the old social group gradually breaking up into its elements, with diversity of interests and a degree of hostility between the separate family groups. Each of these, in its turn, grew larger and larger, until it became a community in itself, held together by a strongly-felt sense of blood-relationship, and quite able to hold its own against other similar groups.

The most archaic of these communal groups is the patriarchal, that still found throughout nomadic Asia. It is distinctly based on family relations, recognizes a common ancestor, is governed by the living representative of this ancestor, and strongly holds to the fiction of blood relationship, even in adopted members of the tribe. Again, all property is held and all labor performed in common, and for the good of the community, while the sentiment of individualism is very greatly reduced. This is not now so strictly the case as it probably was of old, yet the principle of communalism is still strongly maintained.

Yet, as in the beavers, so in the patriarchal horde, there are minor groups within the group, tent-families like the lodge-family of the beavers, with more immediate family links than those of the larger group. Among the primitive Aryans this minor division had made great progress. The separation of the patriarchal community into minor family groups, with special interests and common property, had become strongly marked, and a reverse process of development, from communalism toward individualism, had fairly set in. The Aryan village community had still many interests in common, and held the fiction of a common ancestor. Yet it had taken a step in advance of the stage reached by the communal animals, toward the higher and special development of modern human society.

Between the patriarchal and the Aryan systems of association stands that of the Indian clan, which possessed features of both. The general family group was broken up into smaller family groups, as well defined as the Aryan, yet the division of property had not advanced so far. And not only property was held to a considerable extent in common, but common habitation existed among many tribes, of which we have the most marked and striking instance in the great common habitations of the Pueblo Indians of to-day.

In the later stages of human development there has been a strongly declared progress toward individualism, at least in property and political relations. The family association has vanished, and has been replaced by the *territorial*, which is the link of connection in all modern civilized societies, and the latest outgrowth of the principle of animal association. Yet industrially the communal principle holds good, though it has assumed a new and wider phase than that of old. Though the idea of community in property has lost its force, the sentiment that the labor of each is for the good of all is stronger than ever. It is not expressly formulated, but it exists everywhere in practice. Men work less and less for their individual interests, and more and more for the good of the community. The woodsman who fells a tree in a Western forest has no thought of using its wood for himself. He neither knows nor cares what may become of it. But he knows that in one region a farmer is raising grain, and in another an artisan is weaving cloth, and that some of these will come to him in exchange for his labor. And between woodsman, farmer, and artisan, are fifty or five hundred other individuals, each of whom takes some part in this exchange of products. Neither of these parties works directly for himself, yet each works for the good of all in a far higher and more developed sense than in the analogous case of the communal insects.

It is necessary now to return to another phase of the subject here considered, that relating to the intellectual development of animals. It has often been a source of wonder that the ants and bees have advanced so far in intellectual achievement beyond all other members of the insect class, and that many of their habits and institutions so closely simulate those of human society. This latter, indeed, is but another evidence of the law above considered, that all evolution, whether physical or mental, is controlled by one general principle, and must follow one naturally determined course. But the superior intellectuality of these low forms of life is in itself a phenomenon that calls for some special attention.

A glance at the situation at once reveals that this superiority of intellectual progress must in some way be connected with the communal stage of association, since it is manifested only by the communal animals, the ants, bees, termites, and beavers, and is not shown in any of the solitary species of these zoölogical groups. Evidence pointing in the same direction may be found in the habits of the social animals, which seem to have reasoned out the expedient of stationing sentries to guard them against danger while feeding. And it is interesting in this connection to perceive that the elephants, the most advanced of the herbivora in social combination, likewise display the greatest intellectual advancement.

We might deduce from these facts either the conclusion that intellectual development is favored by close association and communalism, or the reverse conclusion that an original superior intellectuality was the inciting cause of communal association. A consideration of all the facts of the case seems to prove that the former conclusion is the correct one. For observation indicates that individually the communal insects are not superior in intellect to the solitary species. Take the ant beyond the range of his hereditary instincts, and he seems a duller creature than the spider. The same conclusion applies to the beaver, which is said to be much duller, so far as individual powers of intellect are concerned, than many other vertebrates. In fact, in Romanes's work on "Animal Intelligence," the highest powers of intellect are ascribed to the carnivora, which as a general rule are solitary animals. And this is a natural result of the fact that they are obliged to depend upon their own powers in all the exigencies of life, and can not trust to others to relieve them from some of the duties of existence.

Much has been said about the highly remarkable powers of the minute mass of nerve-substance in an ant's head. Yet the brain of every animal has undoubtedly a double duty to perform. It is partly devoted to the control of the muscular organization, partly to psychical activity. And to this we must ascribe the increase in size of brain that generally attends increase in size of body among animals. Though the brain of a large animal may be much larger than that of a small one, this may be mainly due to the increase of its motor duties, and there may be no increase in its psychical portion. In fact, in certain large extinct animals, with greatly developed posterior structure, a sort of second brain seems to have existed at the rear extremity of the spinal column, as if the motor portion of the brain had moved backward to the region where it was most needed. Yet it is very probable that in any of the higher vertebrates the portion of the brain devoted to psychical functions is considerably greater in volume than the whole brain of the ant. And, if the degree of intelligence be in any sense proportional to the size of its organ, these higher vertebrates should be superior in intellect to the ant.

Such is actually the case. The excursions of the ant-mind beyond the limit of its instincts seem to be exceedingly slight. Those of the mammalian mind are sometimes extensive. If we compare the instances of individual intellect displayed by a cat and an ant, for instance, we can not avoid the conclusion that the cat is very greatly superior in powers of reasoning. Yet no cat tribes keep cows, marshal armies, store provisions, enslave captives, or perform any of the wonderful series of intellectual acts which are common in ant communities, and which form part of the powers of every ant-brain. How shall we account for this difference in results? It seems evident that it is in some way due to difference in modes of association. The powers of the ant are instinctive—that is, they have been passed down by hereditary transmission through numerous generations. They are the outcome of not one brain, but of innumerable brains. Though the brain of one ant be minute, yet the brains of a million ants would form a considerable mass, and every act of ant intellect is probably the product of several millions of ant-brains, each of which may have added some minute increment to the final result.

There are, in fact, two distinct methods by which the intellectual powers of ancestors may be transmitted to descendants. One of these is the hereditary, the other the experimental. Among solitary animals the special intellectual achievements of each animal are in great measare lost. They are unseen by others, and the experience of each dies with it. For, as we well know, it is only the general, not the special powers of the mind that are transmitted by heredity. No child is born with the special knowledge of its parents, though it may possess all the intellectual tendencies and powers of its parents. Only when some action is repeated generation after generation does it produce so strong an impress upon the intellect as to be hereditarily transmitted. In this case we have the inheritance of an instinct, or strong special mental tendency.

It is evident that among social animals acts of special shrewdness performed by any individual are likely to be seen and may be imitated by others. In such cases an educational is added to the hereditary method of intellectual transmission. Any such acts, if of special value to the community, may be very frequently repeated, and if the community be long kept together it may make important steps of progress in this method alone. When, again, communities pass from the social to the communal phase of association the influence above mentioned must act with much greater vigor. For the members of communal are much more closely associated than those of social groups. They work more together, and are brought into more intimate association in all the details of life. It is claimed by some writers that the young actually go to school to the old, and are specially taught the duties of the hive and the ant-hill.* In addition to this there is much reason to believe that the communities of communal animals are often continuous for a very long period of time. The ant city does not die out with one generation, but may continue in existence through an indefinite number of generations. The bee family sends out its annual swarms, but the young before this migration are old enough to have been taught all the duties of bee-life. Thus the special habits of a single original hive may be transmitted, in the educational method, to an indefinite number of much later hives. Parallel conditions are known to exist among the beavers. The condition is similar to that of an overcrowded human community, whose younger members migrate in search of a new home, but not until they have learned all the arts of the parental community.

Communalism, therefore, has its special value as an aid to the transmission of knowledge and useful habits through teaching and observa-

* Romanes says that the "house-bees" are the younger bees left at home, for domestic duties, with only a small proportion of older ones, left probably to direct the young. The young ant "is led about the nest, and trained to a knowledge of domestic duties, especially in the case of larvæ. Later on the young ants are taught to distinguish between friends and foes. When an ant-nest is attacked by foreign ants the young ants never join in the fight, but confine themselves to removing the pupæ." In a nest made by Forel of young ants and pupæ of different species, no hostility arose. They dwelt together as a happy family. They had not been educated into hostility to foreigners. Lubbock says, "It is remarkable how much individual ants appear to differ from one another in character." There is thus a natural basis for the development of new habits.

tion. It also induces the incessant reiteration of acts that have proved beneficial to the community, until the tendency to perform these acts becomes so strong that it is hereditarily transmitted. In other words, it tends to produce instincts. In fact, in the case of animals of low intellectual vigor, like the ants and bees, it seems probable that new habits, of special value to a community, grow up only by minute increments, and through long periods of time. Each when gained becomes repeated through innumerable generations, and finally becomes an instinct, capable of hereditary transmission. In this way animals of very slight intellectual vigor, by the educational transmission of all beneficial individual acts, may have gradually gained the diversified mental conditions of these two remarkable types.

In ant and bee communities, as at present constituted, the hereditary transmission of new arts seems at first sight impossible. Intellectual acts performed by the workers must remain unknown to the solitary female, who can only transmit the ancient instincts. It would seem as if the development of communalism had reached a point at which intellectual progress must stop. The general habits of ants and bees were probably gained during their slow evolution of communalism from socialism, and ere the sexual relations had attained their present extreme restriction. With but one female, who takes no part in the duties of home or field, and remains ignorant of any shrewd act that may be performed by a worker, it seems impossible that the existing instincts should receive any addition.

Yet this is not quite impossible, even in the present conditions of ant and bee life. Experiential development and transmission of new habits may continue indefinitely, since single communities may continue in existence, or may yield direct colonies, for indefinite periods of years. And the occasional birth of males from workers affords a possible means by which these habits may be hereditarily transmitted, since it is quite conceivable that these male children of workers may become the parents of new communities. In bee communities the occasional transformation of a worker into a queen affords a direct means for the transmission of worker characteristics. The case is closely parallel to that of the transmission of knowledge in human communities, though in the latter hereditary transmission is of limited scope, and education is the great agent in the communication of knowledge.

Special attention has here been given to this question, as it is one that has excited much comment and debate, and the thoughts here advanced may not be without their interest and value. I would but repeat what is above said, that the remarkable institutions of ant and bee communities do not indicate any intellectual superiority to solitary animals in the members of these communities, but simply a much superior method for the transmission of intellectual results. And to this may be added the final conclusion that while ant and bee communalism has now reached a stage that must tend in great measure to check the hereditary transmission of new habits, yet it is possible that a slow improvement in the habits of these communities may still continue, both by education or observation and by heredity.

The mental relations of animal communities, as thus reviewed, apply closely to the question of the intellectual development of man. Among the quadrumana socialism is often greatly developed, educational transmission is common, and much intellectual shrewdness is manifested. But, between the intellectuality of these communities and those of the ants and bees, there is a marked difference. We speak of the monkey as marked by incessant curiosity. That is to say, he makes constant mental excursions beyond the range of his hereditary habits. He constantly "wants to know." His intellectual acumen is far superior to that of the low animal tribes, which have advanced so far beyond him in habits. In man the same "want to know" has ever been active, and to it are due his rapid gaining of new experiences and increase in knowledge. Yet, so far as social organization is concerned, he was very long in reaching the level attained by the communal animals. He probably continued for ages in the social state, though it is impossible to say how early the patriarchal state may have been reached. Three or four thousand years ago we find the ancestors of the present civilized nations everywhere organized under conditions closely analogous to those of ant and bee communities, though in their mental acumen and variety of habits and knowledge they were almost infinitely superior.

With one further consideration we may close. It is of interest to perceive that in human communities the transmission of intellectual habits is mainly and almost entirely a consequence of education, either direct or indirect. Instinct is almost non-existent, so far as the industrial and intellectual habits of life are concerned. We might destroy an ant city, with the exception of a single male and female, yet these would give rise to a new city, with no perceptible difference in powers from the old. Yet were we to destroy a civilized human community, with the exception of a few infants, these, could they give rise to descendants, in isolated localities, would yield a community nearly destitute of knowledge and of the power of dealing with Nature. They would have to begin anew, where their ancestors began ages before. Yet they would possess mental powers and tendencies that would enable them to rapidly gain new experience and habits, and would undoubtedly develop into a new civilization with exceedingly greater rapidity than was shown in the development of primeval man.

It is the rapidity of progress in human habits and knowledge that prevents any of these habits becoming instinctive. Old conditions are rapidly thrown aside and new ones gained, and no method of action is pursued long enough for it to grow into the force of an instinct. The tendency of human progress is to check instinct, and to more and more constantly employ reason, while with the lower animals the tendency is to the development of instincts. And we may close by naming the ants and bees as instances of the extreme unfoldment of the instinctive powers, man as an instance of the greatest checking of instinct and development of the reasoning faculties.

FISH OUT OF WATER.

By GRANT ALLEN.

STROLLING one day in what is euphemistically termed, in equatorial latitudes, "the cool of the evening," along a tangled tropical American field-path, through a low region of lagoons and water-courses, my attention happened to be momentarily attracted from the monotonous pursuit of the nimble mosquito by a small animal scuttling along irregularly before me, as if in a great hurry to get out of my way before I could turn him into an excellent specimen. At first sight I took the little hopper, in the gray dusk, for one of the common, small green lizards, and wasn't much disposed to pay it any distinguished share either of personal or scientific attention. But, as I walked on a little farther through the dense underbrush, more and more of these shuffling and scurrying little creatures kept crossing the path, hastily, all in one direction, and all, as it were, in a formed body or marching phalanx. Looking closer, to my great surprise I found they were actually fish out of water, going on a walking-tour, for change of air, to a new residence—genuine fish, a couple of inches long each, not eel-shaped or serpentine in outline, but closely resembling a red mullet in miniature, though much more beautifully and delicately colored, and with fins and tails of the most orthodox spiny and prickly description. They were traveling across-country in a bee-line, thousands of them together, not at all like the helpless fish out of water of popular imagination, but as unconcernedly and naturally as if they had been accustomed to the overland route for their whole life-times, and were walking now on the king's highway without let or hindrance.

I took one up in my hand and examined it more carefully; though the catching it wasn't by any means so easy as it sounds on paper, for these perambulatory fish are thoroughly inured to the dangers and difficulties of dry land, and can get out of your way when you try to capture them with a rapidity and dexterity which are truly surprising. The little creatures are very pretty, well-formed cat-fish, with bright, intelligent eyes, and a body armed all over, like the armadillo's, with a continuous coat of hard and horny mail. This coat is not formed of scales, as in most fish, but of toughened skin, as in crocodiles and alligators, arranged in two overlapping rows of imbricated shields, exactly like the round tiles so common on the roofs of Italian cottages. The fish walks, or rather shambles along ungracefully, by the shuffling movement of a pair of stiff spines placed close behind his head, aided by the steering action of his tail, and a constant snake-like wriggling motion of his entire body. Leg-spines of somewhat the same sort are found in the common English gurnard, and, in this age of aquariums and fisheries exhibitions, most adult persons above the age of twenty-one years must have observed the gurnards themselves crawling along suspiciously by their aid at the bottom of a tank at the Crystal Palace or the polyonymous South Kensington building. But, while the European gurnard only uses his substitutes for legs on the bed of the ocean, my itinerant tropical acquaintance (his name, I regret to say, is Callichthys) uses them boldly for terrestrial locomotion across the dry lowlands of his native country. And, while the gurnard has no less than six of these pro-legs, the American land-fish has only a single pair with which to accomplish his arduous journeys. If this be considered as a point of inferiority in the armor-plated American species, we must remember that while beetles and grasshoppers have as many as six legs apiece, man, the head and crown of things, is content to scramble through life ungracefully with no more than two.

There are a great many tropical American pond-fish which share these adventurous gypsy habits of the pretty little Callichthys. Though they belong to two distinct groups, otherwise unconnected, the circumstances of the country they inhabit have induced in both families this queer fashion of waddling out courageously on dry land, and going on voyages of exploration in search of fresh ponds and shallows new, somewhere in the neighborhood of their late residence. One kind in particular, the Brazilian Doras, takes land-journeys of such surprising length that he often spends several nights on the way, and the Indians who meet the wandering bands during their migrations fill several baskets full of the prey thus dropped upon them, as it were, from the kindly clouds.

Both Doras and Callichthys, too, are well provided with means of defense against the enemies they may chance to meet during their terrestrial excursions; for in both kinds there are the same bony shields along the sides, securing the little travelers, as far as possible, from attack on the part of hungry piscivorous animals. Doras further utilizes its powers of living out of water by going ashore to fetch dry leaves, with which it builds itself a regular nest, like a bird's, at the beginning of the rainy season. In this nest the affectionate parents carefully cover up their eggs, the hope of the race, and watch over them with the utmost attention. Many other fish build nests in the water, of materials naturally found at the bottom; but Doras, I believe, is the only one that builds them on the beach, of materials sought for on the dry land.

Such amphibious habits on the part of certain tropical fish are easy enough to explain by the fashionable clew of "adaptation to environment." Ponds are always very likely to dry up, and so the animals that frequent ponds are usually capable of bearing a very long deprivation of water. Indeed, our evolutionists generally hold that land-animals have in every case sprung from pond-animals which have gradually adapted themselves to do without water altogether. Life, according to this theory, began in the ocean, spread up the estuaries into the greater rivers, thence extended to the brooks and lakes, and finally migrated to the ponds, puddles, swamps, and marshes, whence it took at last, by tentative degrees, to the solid shore, the plains, and the mountains. Certainly the tenacity of life shown by pond-animals is very remarkable. Our own English carp bury themselves deeply in the mud in winter, and there remain in a dormant condition many months entirely without food. During this long hibernating period, they can be preserved alive for a considerable time out of water, especially if their gills are, from time to time, slightly moistened. They may then be sent to any address by parcels-post, packed in wet moss, without serious damage to their constitution; though, according to Dr. Günther, these dissipated products of civilization prefer to have a piece of bread steeped in brandy put into their mouths to sustain them beforehand. In Holland, where the carp are not so sophisticated, they are often kept the whole winter through, hung up in a net to keep them from freezing. At first they require to be slightly wetted from time to time, just to acclimatize them gradually to so dry an existence; but after a while they adapt themselves cheerfully to their altered circumstances, and feed on an occasional frugal meal of bread and milk with Christian resignation.

Of all land-frequenting fish, however, by far the most famous is the so-called climbing-perch of India, which not only walks bodily out of the water, but even climbs trees by means of special spines, near the head and tail, so arranged as to stick into the bark and enable it to wriggle its way up awkwardly, something after the same fashion as the "looping" of caterpillars. The tree-climber is a small, scaly fish, seldom more than seven inches long; but it has developed a special breathing apparatus to enable it to keep up the stock of oxygen on its terrestrial excursions, which may be regarded as to some extent the exact converse of the means employed by divers to supply themselves with air under water. Just above the gills, which form of course its natural hereditary breathing apparatus, the climbing-perch has invented a new and wholly original water-chamber, containing within it a frilled bony organ, which enables it to extract oxygen from the stored-up water during the course of its aërial peregrinations. While on shore it picks up small insects, worms, and grubs; but it also has vegetarian tastes of its own, and does not despise fruits and berries. The Indian jugglers tame the climbing-perches and carry them about with them as part of their stock in trade; their ability to live for a long time out of water makes them useful confederates in many small tricks which seem very wonderful to people accustomed to believe that fish die almost at once when taken out of their native element.

The Indian snakehead is a closely allied species, common in the shallow ponds and fresh-water tanks of India, where holy Brahmans bathe and drink and die and are buried, and most of which dry up entirely during the dry season. The snakehead, therefore, has similarly accommodated himself to this annual peculiarity in his local habitation by acquiring a special chamber for retaining water to moisten his gills throughout his long deprivation of that prime necessary. He lives composedly in semi-fluid mud, or lies torpid in the hard-baked clay at the bottom of the dry tank from which all the water has utterly evaporated in the drought of summer. As long as the mud remains soft enough to allow the fish to rise slowly through it, they come to the surface every now and then to take in a good hearty gulp of air, exactly as gold-fish do in England when confined with thoughtless or ignorant cruelty in a glass globe too small to provide sufficient oxygen for their respiration. But when the mud hardens entirely they hibernate, or rather æstivate, in a dormant condition until the bursting of the monsoon fills the ponds once more with the welcome water. Even in the perfectly dry state, however, they probably manage to get a little air every now and again through the numerous chinks and fissures in the sun-baked mud. Our Aryan brother then goes a-fishing playfully with a spade and bucket, and digs the snakehead in this mean fashion out of his comfortable lair with an ultimate view to the manufacture of pillau. In Burmah, indeed, while the mud is still soft the ingenious Burmese catch the helpless creatures by a still meaner and more unsportsmanlike device. They spread a large cloth over the slimy ooze where the snakeheads lie buried, and so cut off entirely for the moment their supply of oxygen. The poor fish, half-asphyxiated by this unkind treatment, come up gasping to the surface under the cloth in search of fresh air, and are then easily caught with the hand and tossed into baskets by the degenerate Buddhists.

Old Anglo-Indians even say that some of these mud-haunting Oriental fish will survive for many years in a state of suspended animation, and that, when ponds or *jhils* which are known to have been dry for several successive seasons are suddenly filled by heavy rains, they are found to be swarming at once with full-grown snakeheads, released in a moment from what I may venture to call their living tomb in the hardened bottom. Whether such statements are absolutely true or not the present deponent would be loath to decide dogmatically; but, if we were implicitly to swallow everything that the old Anglo-Indian in his simplicity assures us he has seen—well, the clergy would have no further cause any longer to deplore the growing skepticism and unbelief of these latter unfaithful ages.

This habit of lying in the mud and there becoming torpid may be looked upon as a natural alternative to the habit of migrating across-country, when your pond dries up, in search of larger and more permanent sheets of water. Some fish solve the problem how to get through the dry season in one of these two alternative fashions, and some in the other. In flat countries where small ponds and tanks alone exist, the burying plan is almost universal; in plains traversed by large rivers or containing considerable scattered lakes, the migratory system finds greater favor with the piscine population.

One tropical species which adopts the tactics of hiding itself in the hard clay, the African mud-fish, is specially interesting to us human beings on two accounts: first, because, unlike almost all other kinds of fish, it possesses lungs as well as gills; and, secondly, because it forms an intermediate link between the true fish and the frogs or amphibians, and therefore stands in all probability in the direct line of human descent, being the living representative of one among our own remote and early ancestors. Scientific interest and filial piety ought alike to secure our attention for the African mud-fish. It lives its amphibious life among the rice-fields on the Nile, the Zambesi, and the Gambia, and is so greatly given to a terrestrial existence that its swim-bladder has become porous and cellular, so as to be modified into a pair of true and serviceable lungs. In fact, the lungs themselves in all the higher animals are merely the swim-bladders of fish, slightly altered so as to perform a new but closely allied office. The mud-fish is common enough in all the larger English aquariums, owing to a convenient habit in which it indulges, and which permits it to be readily conveyed to all parts of the globe on the same principle as the vans for furniture. When the dry season comes on and the rice-fields are reduced to banks of baking mud, the mud-fish retire to the bottom of their pools, where they form for themselves a sort of cocoon of hardened clay, lined with mucus, and with a hole at each end to admit the air; and in this snug retreat they remain torpid till the return of wet weather. As the fish usually reach a length of three or four feet, the cocoons are of course by no means easy to transport entire. Nevertheless, the natives manage to dig them up whole, fish and all; and, if the capsules are not broken, the unconscious inmates can be sent across by steamer to Europe with perfect safety. Their astonishment when they finally wake up after their long slumber, and find themselves inspecting the British public, as introduced to them by Mr. Farini, through a sheet of plate-glass, must be profound and interesting.

In England itself, on the other hand, we have at least one kind of fish which exemplifies the opposite or migratory solution of the dry-pond problem, and that is our familiar friend the common eel. The ways of eels are indeed mysterious, for nobody has ever yet succeeded in discovering where, when, or how they manage to spawn; nobody has ever yet seen an eel's egg, or caught a female eel in the spawning condition, or even observed a really adult male or female specimen of perfect development. All the eels ever found in fresh water are immature and undeveloped creatures. But eels do certainly spawn somewhere or other in the deep sea, and every year, in the course of the summer, flocks of young ones, known as elvers, ascend the rivers in enormous quantities, like a vast army under numberless leaders. At each tributary or affluent, be it river, brook, stream, or ditch, a proportionate detachment of the main body is given off to explore the various branches, while the central force wriggles its way up the chief channel, regardless of obstacles, with undiminished vigor. When the young elvers come to a weir, a wall, a flood-gate, or a lasher, they simply squirm their way up the perpendicular barrier with indescribable wrigglings, as if they were wholly unacquainted, physically as well as mentally, with Newton's magnificent discovery of gravitation. Nothing stops them ; they go wherever water is to be found ; and, though millions perish hopelessly in the attempt, millions more survive in the end to attain their goal in the upper reaches. They even seem to scent ponds or lakes mysteriously, at a distance, and will strike boldly straight across-country, to sheets of water wholly cut off from communication with the river which forms their chief highway.

The full-grown eels are also given to journeying across-country in a more sober, sedate, and dignified manner, as becomes fish which have fully arrived at years, or rather months, of discretion. When the ponds in which they live dry up in summer, they make in a bee-line for the nearest sheet of fresh water, whose direction and distance they appear to know intuitively, through some strange instinctive geographical faculty. On their way across-country they do not despise the succulent rat, whom they swallow whole, when caught, with great gusto. To keep their gills wet during these excursions, eels have the power of distending the skin on each side of the neck, just below the head, so as to form a big pouch or swelling. This pouch they fill with water, to carry a good supply along with them until they reach the ponds for which they are making. It is the pouch alone that enables eels to live so long out of water under all circumstances, and so incidentally exposes them to the disagreeable experience of getting skinned alive, which, it is to be feared, still forms the fate of most of those that fall into the clutches of the human species.

A far more singular walking fish than any of these is the odd creature that rejoices (unfortunately) in the very classical surname of Periophthalmus, which is, being interpreted, Stare-about. (If he had a recognized English name of his own, I would gladly give it ; but, as he hasn't, and as it is clearly necessary to call him something, I fear we must stick to the somewhat alarming scientific nomenclature.) Periophthalmus, then, is an odd fish of the tropical Pacific shores, with a pair of very distinct fore-legs (theoretically described as modified pectoral fins), and with two goggle-eyes, which he can protrude at pleasure right outside the sockets, so as to look in whatever direction he chooses, without even taking the trouble to turn his head to left or right, backward or forward. At ebb-tide this singular peripatetic goby literally walks straight out of the water, and promenades the bare beach erect on two legs in search of small crabs and other stray marine animals left behind by the receding waters. If you try to catch him, he hops away briskly much like a frog, and stares back at you grimly over his left shoulder with his squinting optics. So completely adapted is he for this amphibious 'longshore existence that his big eyes, unlike those of most other fish, are formed for seeing in the air as well as in the water. Nothing can be more ludicrous than to watch him suddenly thrusting these very movable orbs right out of their sockets like a pair of telescopes, and twisting them round in all directions so as to see in front, behind, on top, and below, in one delightful circular sweep.

There is also a certain curious tropical American carp, which, though it hardly deserves to be considered in the strictest sense as a fish out of water, yet manages to fall nearly half-way under that peculiar category, for it always swims with its head partly above the surface and partly below. But the funniest thing in this queer arrangement is the fact that one half of each eye is out in the air and the other half is beneath in the water. Accordingly, the eye is divided horizontally by a dark strip into two distinct and unlike portions, the upper one of which has a pupil adapted to vision in the air alone, while the lower is adapted to seeing in the water only. The fish, in fact, always swims with its eye half out of the water, and it can see as well on dry land as in its native ocean. Its name is Anableps, but, in all probability, it does not wish the fact to be generally known.

The flying-fish are fish out of water in a somewhat different and more transitory sense. Their aërial excursions are brief and rapid; they can only fly a very little way, and have soon to take once more for safety to their own more natural and permanent element. More than forty kinds of the family are known, in appearance very much like English herrings, but with the front fins expanded and modified into veritable wings. It is fashionable nowadays among naturalists to assert that the flying-fish don't fly; that they merely jump horizontally out of the water with a powerful impulse, and fall again as soon as the force of the first impetus is entirely spent. When men endeavor to persuade you to such folly, believe them not. For my own part, I have seen the flying-fish fly—deliberately fly, and flutter, and rise again, and change the direction of their flight in mid-air, exactly after the fashion of a big dragon-fly. If the other people who have watched them haven't succeeded in seeing them fly, that is their own fault, or, at least, their own misfortune; perhaps their eyes weren't quick enough to catch the rapid, though to me perfectly recognizable, hovering and fluttering of the gauze-like wings; but I have seen them myself, and I maintain that on such a question one piece of positive evidence is a great deal better than a hundred negative. The testimony of all the witnesses who didn't see the murder committed is as nothing compared with the single testimony of the one man who really did see it. And in this case I have met with many other quick observers who fully agreed with me against the weight of scientific opinion, that they have seen the flying-fish really fly with their own eyes, and no mistake about it. The German professors, indeed, all think otherwise; but then the German professors all wear green spectacles, which are the outward and visible sign of "blinded eyesight poring over miserable books." The unsophisticated vision of the noble British seaman is unanimously with me on the matter of the reality of the fishes' flight.

Another group of very interesting fish out of water are the flying gurnards, common enough in the Mediterranean and the tropical Atlantic. They are much heavier and bigger creatures than the true flying-fish of the herring type, being often a foot and a half long, and their wings are much larger in proportion, though not, I think, really so powerful as those of their pretty little silvery rivals. All flying-fish fly only of necessity, not from choice. They leave the water when pursued by their enemies, or when frightened by the rapid approach of a big steamer. So swiftly do they fly, however, that they can far outstrip a ship going at the rate of ten knots an hour; and I have often watched one keep ahead of a great Pacific liner under full steam for many minutes together in quick, successive flights of three or four hundred feet each. Oddly enough, they can fly farther against the wind than before it—a fact acknowledged even by the spectacled Germans themselves, and very hard indeed to reconcile with the orthodox belief that they are not flying at all, but only jumping. I don't know whether the flying gurnards are good eating or not; but the silvery flying-fish are caught for market (sad desecration of the poetry of Nature!) in the Windward Islands, and, when nicely fried in egg and bread-crumb, are really quite as good, for practical purposes, as smelts or whiting, or any other prosaic European substitute.

On the whole, it will be clear, I think, to the impartial reader, from this rapid survey, that the helplessness and awkwardness of a fish out of water have been much exaggerated by the thoughtless generalization of unscientific humanity. Granting, for argument's sake, that most fish prefer the water, as a matter of abstract predilection, to the dry land, it must be admitted *per contra* that many fish cut a much better figure on *terra firma* than most of their critics themselves would cut in mid-ocean. There are fish that wriggle across-country intrepidly with the dexterity and agility of the most accomplished snakes; there are fish that walk about on open sand-banks, semi-erect on two legs, as easily as lizards; there are fish that hop and skip on tail and fins in a manner that the celebrated jumping-frog himself might have observed with envy; and there are fish that fly through the air of heaven with a grace and swiftness that would put to shame innumerable species among their feathered competitors. Nay, there are even fish, like some kinds of eels and the African mud-fish, that scarcely live in the water at all, but merely frequent wet and marshy places, where they lie snugly in the soft ooze and damp earth that line the bottom. If I have only succeeded, therefore, in relieving the mind of one sensitive and retiring fish from the absurd obloquy cast upon its appearance when it ventures away for a while from its proper element, then, in the pathetic and prophetic words borrowed from a thousand uncut prefaces, this work will not, I trust, have been written in vain.—*Cornhill Magazine.*

THE FLOWER OR THE LEAF.

By Dr. MARY PUTNAM-JACOBI.

"Quod she agen, 'But to whom do ye owe
Your service? and which wolle ye honour,
Tel me I pray, this yere, the Leaf or the Flower?'"
CHAUCER, "The Flower and the Leaf."

THE comments made by Miss Youmans,* upon a single remark in my article on "Primary Education," show how much can be unfolded out of an apparently limited subject, when all its bearings are thoroughly discussed. Already this discussion trenches upon several philosophical principles which involve much more than the apparently trivial question whether children should begin the study of botany by the flower or the leaf. An inquiry into these principles may therefore be not uninteresting.

Miss Youmans lays down certain propositions, with some of which I do in reality agree, while with others I am in decided disagreement, for reasons I will take the liberty of here setting forth. Thus:

1. Children should study the external characters of plants before attempting to study their life-processes or physiology.

2. Children can not be suitably impressed with such "tremendous ideas as evolution," and therefore it is useless to signalize these to them.

3. Children should not be detained to draw the leaves or other natural objects they study, because of "the delay" thus entailed, and because "they could not draw one in a hundred of the specimens with which it is necessary that they become familiar."

4. The modern systems of botanical classification are based on the sum total of the characters of the plant, and not on the corolla. It is therefore unphilosophical to study the flower containing the corolla

* "Popular Science Monthly," October, 1885.

first, merely because it is more showy. The sensuous pleasure derived from its contemplation is superficial as compared with the deeper intellectual pleasure of tracing the scientific relations of the leaf.

5. Finally, it is an axiom that can not be disputed, that mental effort should advance from the simple subject to the more complex. The leaf is much simpler than the flower, and is therefore much better suited for beginning the study of botany.

To consider these propositions in order: 1 and 2. In regard to the first I am substantially in entire agreement with Miss Youmans, as indeed is shown by the examples given in the "Experiment." No attempt was made to really study the physiology of plants; while the external and obvious characters of the most conspicuous portions, the parts, namely, of the flower, were studied, or rather submitted to a prolonged contemplation. Only, upon first crossing the threshold of this new world, the most characteristic facts which distinguished it were pointed out in a manner designed to make as profound an impression as possible upon the imagination. These are the facts of life and growth and death, the germination of the seed, the influence of surrounding media, the circumstance that the plant offers a constant succession of changing phenomena, and thus was an entirely different object from a stone, or a mathematical figure, or a rainbow. Now, while it is perfectly true that the term "evolution" and the vast series of ideas and masses of facts suggested by it can not be rendered comprehensible to a child, and that it would be the grossest pedantry to even mention it to him, yet the great fact of growth and incessant change in living organisms is perfectly appreciable through impressions made on his senses, and is well fitted to arouse in him a lively interest and curiosity. The fact of life—the essential nature of life as a series of incessant changes—is perhaps the most fundamental fact with which the mind will ever become acquainted. It is also among the most primitive and earliest encountered; the mode of impression it makes upon the mind permanently stamps all the thoughts and systems of thought the mind ever entertains. For, whence spring all religions, and cosmogonies, and even ethical systems, but from the primitive thoughts held upon life and death? How many immoralities depend upon false estimates of life, of its nature, its values! How many erroneous theories of life might be corrected by the early habit of direct, unbiased observation of living things! In the building of a brain, the earliest ideas always remain the most powerful, because upon them the entire mental structure is destined to repose; or, since the mind is a living organism, it were better to compare its primitive ideas, not to the foundation-stones of a house, but to the central medullary rings of a tree. What is on the surface while the plant is young soon becomes central by the successive superposition of new impressions, the new circles being constantly intersected by rays prolonged from the central pith. The selection of the earliest ideas and impressions is therefore of the highest importance; they should be not only negatively good, that is, innocent, but, when possible, really powerful, that is, brought from the depths of things, and able to sustain all the future life of the mind possessing them. And, since direct perception of facts must precede reasoning upon the inferences which may be drawn from them, it is not only legitimate but important to impress the imagination with typical and fundamental facts, long before these can be reasoned upon, or their laws really understood. This is my lengthy reason for the simple experiment of studying the growth of beans on a saucer of cotton-wool—experiment designed not to teach physiology, but to make an early revelation of life.

In this connection, however, is worth noting a special reason for preferring the flower to the leaf for early study. It is agreed that the functions of living organisms are too difficult for such study; nevertheless, it is desirable to *indicate* functions when possible, because the fact of function is one eminently characteristic of living things. Now, the function of the leaf is respiration, which can not possibly be made intelligible to the child. It involves chemical relations, which are the latest appreciable, and can not be exhibited except by means of experiments, for which the young child is quite unprepared. The absence of the visible phenomena of animal respiration, moreover, that is of the exhalation of the breath and movements of the thorax, render an attempt to identify the function in plants and animals confusing and apparently contradictory.

On the other hand, the function of the flower—reproduction—can be rendered perfectly intelligible to the child, when he is told that the pollen feeds the ovules, which then visibly grow into seeds, while the ovary ripens to fruit. This statement seems to the child in accordance with his own most urgent personal necessities, and in the common facts of feeding and growth he finds himself linked with other organisms in Nature. It is quite congenial to the normal fetichism of a young child's mind to regard plants as animals; and legends of dryads are as natural to him as to the infancy of the human race.

But the assimilation of animals to plants through the molecular processes of nutrition common to both (though perhaps unconsciously foreshadowed in the story of Narcissus) was not for mankind distinctly formulated until the time of Bichat; and, for the individual intelligence, its comprehension must be deferred until nearly to adolescence.

3. I must plead guilty to an inaccuracy when, quoting from memory, I said that Miss Youmans recommended her pupils to *draw* the leaves that they studied. But I fell into the error all the more readily, because such a direction entirely commended itself to my own judgment. Nor can I agree at all with the reasons which Miss Youmans now advances in opposition to this method. If the aim at the time be not to learn botany, but "to cultivate the observing powers

of children," what danger is there in a "delay" which permits the object to become more deeply graven on the child's mind? Why is it so "necessary to become familiar with hundreds of specimens" in a given time? Why not rather with a few, a very few striking and typical forms, around which subsequent knowledge can group itself? The comparison of a multitude of objects in order to abstract their common characters, and thus obtain the generic or class conception, is suited to the scientific but not to the pre-scientific stage of progress. It does not, therefore, belong to the fruitful moment of first attraction to an object, which, for the adult mind, precedes scientific discovery, and contains the hidden forces which lead to this. Still less does it belong to the first mental efforts of childhood. Early childhood is a period for the differentiation of the details of a universe, which, to the earliest perceptions, appears to consist entirely of homogeneous masses of light and shade. In the first efforts of the mind these masses are broken up and separated from one another, and portions reintegrated into actual individuals. Thus the moon is separated from the window-pane, the child's limbs are integrated into a body, which at last is positively known to be different from other moving forms, etc. It is in accordance with this spontaneous and, indeed, inevitable mode of development of perception that the first educated efforts of perception should be directed toward the more intense individualization of objects, and not to their classification; toward the thorough appreciation of specific differences rather than to that of generic resemblances. Hence, a second reason for beginning the study of botany—say, rather, the observation of life—with the flower, although more complex, and not with the simpler leaf. It is because the individual differences of the flower are so much more striking, and—as the poets show us—the flower is so much more readily individualized and personified.*

The period of development with which my "experiment" was concerned may be called the pre-scientific stage of mental existence. It is that during which the mind may be busily occupied in collecting the data for science, but can not itself wield scientific methods. Its efforts should be directed in accordance with scientific principles of psychology, and the knowledge acquired arranged in such orderly sequence that, when the mind is ripe for them, scientific relations will be readily perceived and understood. But discussion of such relations seems to me entirely premature for the age here considered, and, indeed, for a much later period.

Scientific observation is observation of the relations between things. But, before any attempt be made to study these relations, the things themselves should be firmly and clearly apprehended. The different degree of grasp possessed by different minds depends largely upon

* Trees, however, seem to have occasionally shared the poetic individualization. There is Emerson's "Pine-Tree," and "The Pine and the Palm" of Heine, not to speak of "The Fir-Tree" of Hans Andersen; and who could forget "The Talking Oak"?

differences in the degree of vividness and fervor with which they are impressed by individual objects, which leave so many persons in the most limp indifference, while exciting in others an absorbing and even passionate interest. When the individual impressions are so clear, distinct, characteristic, and interesting as to be quite unforgettable, they soon force upon the mind, after prolonged contemplation of them, suggestions of their multiple relations, and the knowledge which was at first simply picturesque becomes, sooner or later, scientific. The mental power which arrives at this is largely innate, and beyond the capacity of any education to bestow. But if any educational method can increase and develop it, it is that which most nearly imitates the spontaneous habits of fertile and original minds, apart from all systematic intention.

Three characters are conspicuous in the observation exercised by this class of minds: it is single, it is imaginative, and it is indefinitely prolonged. It is single—that is to say, the mind which is powerfully attracted to any object—and none ever discovers anything in any object to which it is not powerfully attracted, is in no haste to detach itself and pass on to anything new; on the contrary, it lingers and hates to go, and delays, and returns again and again to catch still another glimpse of what has been so delightful. To say that an object is suggestive is to say that it constantly opens up new trains of thought, and, so long as this is the case, the mind can not bear to abandon it. It is on this account that the contemplation is indefinitely prolonged, and irregularly so, according to no fixed rule or extrinsic necessity, not even that of mastering a certain quotum of information, but varies in accordance with the infinitely varied accidents of the mental intercourse. Finally, to be fruitful, this intercourse must be imaginative. First, in the lowest and most literal sense of the term, since the mind can not directly handle the sense-perception of the object, but only the mental image of the object, revived and remembered. But, in addition, to detect all its hidden meanings, properties, and possible aspects, many functions of the imagination must be brought into play, and none are useless. Fertility of fancy, rich association of ideas, are as important in collecting the premises for scientific argument as is the argument itself in the discovery of truth.*

During the pre-scientific period, therefore, either in the history of the race, the development of the individual, or the evolution of any single idea in an inquiring mind, the cardinal necessity is that of filling the mind with an abundance of distinct concepts and visual images of real concrete existences. Any prolonged attempt to compare, generalize, or reason about these should be deferred, under penalty of substituting a mere verbal imitation of reasoning for a real effort of the mind. A certain amount of reasoning and comparison will, of course,

* In these respects the mental history of the celebrated Faraday offers a mine of interesting facts and illustrations.

arise incidentally, but it must be kept subordinate to the main purpose. The soil must be enriched before it is plowed. Ideas must be clustered into dense and rich groups, individualities magnified and intensified, as, to keep to our subject, the flowers which are classified by the botanist may be individually magnified into almost conscious beings by the poet.*

* "A nun demure of lowly port,
Or sprightly maiden, of Love's court,
In thy simplicity the sport
Of all temptations;
A queen in crown of rubies drest,
A starveling in a scanty vest,
Are all, as seems to suit thee best,
Thy appellations."—Wordsworth, "To a Daisy."

"While the patient primrose sits
Like a beggar in the cold."—Wordsworth.

"Here are sweet-peas, on tiptoe for a flight
With wings of gentle flush o'er delicate white,
And taper fingers catching at all things
To bind them all about with tiny rings."—Keats.

"Bloomy grapes, laughing from green attire."—Ibid.

"And the rose like a nymph to the bath addrest—
And the hyacinth's purple and white and blue,
Which flung from its bells a sweet peal anew
Of music, so delicate, soft, and intense,
It was felt like an odor within the sense."—Shelley.

". . . daffodils,
That come before the swallow dares, and take
The winds of March with beauty; violets dim,
But sweeter than the lids of Juno's eyes
Or Cytherea's breath."—"Winter's Tale."

"Continuous as the stars that shine
And twinkle in the milky way; . . .
Ten thousand saw I at a glance
Tossing their heads in sprightly dance."
—Wordsworth, "The Daffodils."

"Daisies, those pearled arcturi of the earth,
The constellated flower that never sets."—Shelley.

"The gold-eyed king-cups fine,
The frail blue-bell peereth over
Rare broidery of the purple clover."—Tennyson.

"Open afresh your round of starry folds,
Ye ardent marigolds!"—Keats.

"Death in the wood—
In the death-pale lips apart,
Death, in a whiteness that curdles the blood,
Now black to the very heart.
. . . .
To show that life by the spirit comes,
She gave us a soulless flower."
—Elaine Goodale, "The Indian Pipe."

Hence the suitableness of flowers for making large, forcible, indelible impressions on the imagination and the memory, and for storing the mind at the outset with the most vivid and beautiful conceptions of Nature.

The leaf offers, indeed, a variety of beautiful forms and outlines, which are not, however, either so numerous or so conspicuous as those displayed by the various organs of the flower. Leaves contrast less conspicuously with one another; their sensible differences are much less striking, and the eye of the child is not sufficiently trained to adequately appreciate the subtile differences of color which really exist. To him leaves can scarcely fail to present the vast monotony of green which the primitive vegetation of the earth is said to have exhibited before variegated corollas appeared. It is certainly desirable to repeat for the individual mind the experience of the race; but is it necessary for that to go back to the ages which antedated even the prehistoric man?

In a word, the differences of flowers resembles the "legend writ in large letters" which Plato advised should be first studied; the differences of leaves make the same legend repeated in the "small letters," and therefore more difficult to decipher.*

4. Miss Youmans's reason derived from botanical systems of classification I scarcely understand. It is very true that classification by the corolla is abandoned, and indeed never could have been carried very far. But the natural system, which sums up the total characters of the plant, certainly derives a much larger number of its data from the flower than from any other part of the plant. The great function of the plant is reproduction, and around the organs of reproduction contained in the flower center all its peculiarities. The mutual relations of stamens and pistils have been found inadequate for classification; but the extension of the class lines has still been chiefly in the direction of other parts of the flower, especially the fruit, ovule, and embryo.

Toward the flower converge all the forces of the plant; it is the culmination, the perfection of the entire vegetable organism. It should therefore be contemplated first, because, as it seems to me, it is eminently desirable that the child should, whenever possible, see the principal thing first; since whatever comes first is always liable to remain for him the most important. The habit of ranking things in the order of their real relative importance is certainly a most valuable habit to cultivate, both morally and intellectually. As has already been pointed out, the mind in its growth closely resembles that of a tree; for it, primary facts constantly tend to become central facts, and due organic proportions are only maintained between ideas when the principal, by being placed first, is enabled to become really central, a vitalized center of fitly organized knowledge. For

* "Republic," book ii, 368 (Jowett's translation).

all life develops from centers; and in Nature there are no single lines.

5. Miss Youmans's final proposition, that progress must always be made from the simple to the complex, is the one with which I do most decidedly disagree. The expression itself is ambiguous: for it may mean the transition from the easy to the difficult; or it may mean the study of elements as a preliminary to the study of the compounds into which they enter. In the latter meaning, the proposition can not surely be applied to the leaf and the flower. Morphologically speaking, it is true that all the parts of the flower result from transformations of the leaf, but this fact is altogether too recondite for a child's appreciation. In no other sense can the leaf be said to enter into the flower as an element—to be a "simpler" part of it. No knowledge to be gained of the flower, other than these facts of embryology, presupposes or requires knowledge of the leaf. Study of the one can only be said to prepare for the other by the degree of mental discipline it affords. And the very question at issue is, What is the best for mental discipline, the contemplation of objects with the fewer and less obvious characters, or of objects at once more conspicuous, and more abounding in interesting details? I have already stated the reasons which seem to me to justify the selection of the second method.

The first seems indorsed, and perhaps is intended to be so, by the Comtist classification of the sciences, and by the rather arbitrary attempt of its author to identify this with the actual order of their historic evolution. As regards their subject-matter, it would certainly be untrue to assert that this attracted the attention of mankind in the order of its (philosophically considered) simplicity.* At what appear to us to be the opening periods of Greek thought we find already coexisting the germs of all the six fundamental sciences, if we may assume that even chemistry was foreshadowed in the doctrines of the Four Elements. Such coexistence was inevitable, for the moment that the human mind was aroused enough to observe and theorize about anything, its attention could not fail to be attracted in several different directions simultaneously. It noticed the form and number of objects, and founded the sciences of geometry and arithmetic. But it was quite unaware that these sciences deal with simpler elements than make up human organisms, and believed that physiology and medicine

* "While he [Comte] asserts that the rational order of the sciences, like the order of their historic development, 'is determined by the degree of simplicity, or, what comes to the same thing, of generality of their phenomena,' it might, contrariwise, be asserted that, commencing with the complex and the special, mankind have progressed step by step to a knowledge of greater simplicity and wider generality."—Spencer, "The Genesis of Science."

Mr. Spencer goes on to quote a remark of Whewell's that "the reader has already repeatedly seen in the course of this history complex and derivative principles [read 'objects'] presenting themselves to men's minds before simple and elementary ones."

are far simpler subjects, and far less involved in sublime mysteries, than are mathematics. All subjects were studied, or at least speculated upon, in no other order than that of their apparent nearness to human interests and that of the obviousness of their phenomena.*

Exactly the same is true for every individual mind, whose perceptions are not regularly successive, but simultaneous, and are as liable to be attracted toward infinitely complex objects as toward the simplest details. It is true, as has been pointed out in the "Experiment," that a child's first perceptions are necessarily of form and color, and the ideas of form belong to mathematics. But color is a physical property of bodies, and therefore the subject of a science which is, according to the Comtist measure of simplicity, two degrees removed from mathematics. On the other hand, the property of number, although like forms, mathematical, is not grasped till much after color and many other physical properties have been appreciated.

Other properties of bodies become known in direct proportion to their obviousness, and to their accidental impact on the senses, or to their association with the personal experience of the child. These may be mathematical, physical, biological, or even social. The mind of the child, like that of the race, looks over the surface of all things at once; its progress is not from the simple toward the complex, but from the superficial and obvious toward the profound and hidden. The mutual aid rendered by sciences, when, to use Herbert Spencer's expression, they become *arts* to one another, is only required after the observation and registration of accessible facts are completed, and when analysis is required to bring to light new facts or to explain others. But the child's mind does not reach this stage, and it is either illusory or fatal to attempt to force it prematurely.

It is very interesting to notice, by study of the actual evolution of knowledge, what a large amount of knowledge was obtained simultaneously in each department by independent observation, and before the necessity for mutual help, other than that derived from elementary mathematics, had been perceived. During this period the advance was made in each science, not by deductions from some simpler science, but by observations and methods peculiar to itself. Thus, as already stated, the germs of mathematics, physics, biology, and sociology, are all found coexisting at what seem to us the opening periods of Greek thought; nor was their degree of development at all proportioned to their degree of simplicity. If some truths of geometry and arithmetic were really established, so, in spite of the obscurity surrounding biological laws, were many phenomena of living beings also observed. The pulse was known, if the circulation was not, and numerous are the clinical observations of Hippocrates which still hold

* "The broad distinction between the two orders of knowledge [the ordinary and the scientific] is not in their nature, but in their remoteness from perception."—Spencer, *loc. cit.*

good even in the scientific sphere of prognosis; and who could deny the permanent value of many of the ethical, political, and historical speculations of the ages of Plato, Thucydides, and Aristotle, even though, according to the Comtist doctrine, sociological speculations should have been valueless at this time, because entirely premature?*

The epoch of acquisition of facts, which must precede the discovery of their laws, often stretches over long periods of time—periods which interest us, because corresponding to the moment of education with which this discussion is concerned. The labors of the alchemists accumulated immense material on the composition of bodies and on their more recondite properties long before the scientific relations of chemistry could be established through the law of definite proportions. Physiology, the most complex of the physical sciences, has been most heterogeneous in the methods by which it has established its fundamental facts. The nature of respiration was, indeed, established by a chemist, from chemical data and from chemical experiments. But the nature of the circulation was partly inferred from anatomical facts—the presence of valves in veins—partly demonstrated by vivisection, a method of investigation which could not possibly be suggested by any other science than physiology. Knowledge of physics has materially assisted the interpretation of blood-pressure, of the expansion of the lungs, and many other phenomena, first known by direct observation of them. But the demonstration of the functions of the nervous system has been made exclusively by means of physiological experiment and clinical observation. "Science," observes Renan, "in order to formulate her laws, is obliged to make abstractions and to *create* simple circumstances, such as Nature never presents."† This is done usually with the aid of a simpler science, or one of wider generality, whose mastery thus becomes indispensable to further progress. But, until the moment for analysis and experiment has arrived, observation of the complex object is not more, but rather less difficult than that of the simple one, because in it so many varieties of details offer themselves spontaneously to the attention that the mind is at once fully occupied so soon as it begins to carefully observe; whereas pure observation soon exhausts the details of a simple object or phenomenon, and no further progress can be made until after a profound analysis has plunged below the surface. Let any one compare the rate of progress in the discovery of new knowledge in mathematics, astronomy, and even

* "What has often led linguists to regard the elementary monosyllabism of the Chinese as the primitive condition of all languages is the tendency which leads us to consider simplicity as indicating a state of infancy, or, at least, as the sign of a high antiquity. But this is an error. The Chinese language, though monosyllabic, has served a highly developed civilization; on the other hand, the languages of the savages of America, of Central and Southern Africa, offer a surprising richness of grammatical forms." —RENAN, "De l'Origine du Langage," p. 13 of preface.

† *Loc. cit.*, p. 59.

physics, with that of its incessant registration in chemistry and in all the biological sciences; registration often effected, moreover, by a relatively mediocre order of minds.

The child, like the race, begins at once with two sets of mental activities—sense-impressions, and speculations suggested by them and by emotional experience. Since complex objects are capable of making impressions on its senses, and of suggesting speculation, it is often both possible and profitable to study the external and perceptible characters of these objects, as well as those of simpler ones. The child, like the infant humanity, is incapable of profound anlysis, and a premature habit of analysis is morally destructive.* It is this very incapacity which makes the complexity of objects a matter of indifference, since it is only by analysis that the difference between simple and complex objects can be recognized or felt. Whatever makes a large impression upon the senses is, other things being equal, easy of apprehension, even when not of *com*prehension. Whatever does not do so, whatever demands the intervention of abstract reasoning and inference, is difficult—often so difficult as to be really impossible—even though the child pretend and appear to understand.

And thus, to return to our starting-point, it is for all of these reasons that I have preferred to introduce the world of plants by the flower, with its marvelous variety in form and color, in port and expression and inflorescence, in contrivance of petal and stamen and pistil, and in manifold destiny of fruit. I would, undoubtedly, and in accordance with the principle already laid down of indicating many things on the mental horizon before the time should arrive for paying systematic attention to them, bring forward a few salient leaves as types: the needles of the pine, the rounded floating leaves of the water-lily, the truncated leaves of the tulip-tree, the five-fingered leaves of the maple, the pinnated leaves of the sumach, the asymmetrical leaves of the begonia, the woolly leaves of the mullein. But I should reserve the systematic study of "hundreds of specimens" to a much later period, and then enter upon it with all possible enthusiasm, and prepared to especially consider the numerous mathematical relations presented by these exquisite organic forms. Not only through study of their geometric outline, but in their multiple arithmetic combinations of insertion and section, may the pupil be led to the fruitful modern methods which involve the application of mathematics to the non-mathematical sciences.†

* The effect of this is shown in the autobiography of John Stuart Mill, as the author himself points out in a striking chapter.

† See "Études comparées des Feuilles," par M. Fermond, 1864.

THE STUDY OF THE RELATIONS OF THINGS.

By ELIZA A. YOUMANS.

EVERY reader of the preceding article will recognize that it is one which I can not let pass as a final statement of the subject. Mrs. Jacobi's very first sentence is so misleading as to put me in a wrong relation to this discussion. She says, "The comments made by Miss Youman's upon a single remark in my article on primary education," etc.; the implication of which is that I had a very slender basis for getting up a controversy. But her "single remark" was in point of fact a complete paragraph of nearly a page in length containing a series of affirmations, condemning the principles adopted as fundamental in my First Book of Botany. Her criticisms, besides, acquired special force from the circumstances in which they were made. Mrs. Jacobi is a trained scientific scholar, an independent inquirer untrammeled by traditions, and she had taken up the critical study of primary education in connection with the practical management of her own child, and published two articles on her method and its results. All this gave such strength to the case, that her incidental comment upon my method, if allowed to pass without notice, would have been more injurious than would have been a separate and formal attack. That I did not mistake the import of her first critical passage is now sufficiently apparent, as her present elaborate article is but an amplification and a justification of positions taken at the outset.

As will have been seen by the reader, Mrs. Jacobi sums up my views in five propositions upon which she comments in their order. With the first proposition she agrees, and with the second she is in partial agreement. But, while admitting that ideas of evolution are unsuitable to childhood, she insists that the idea of life and its changes is proper for their very early contemplation. I have only to say, as I said in my former article, that I have gone as far as she has done in this direction of objective study, having provided a series of experiments in the sprouting and growth of various seeds in my "First Book." But while I should be content to furnish the child with materials for simple observation, and leave him very much to himself to find out what his experiments disclose, Mrs. Jacobi would use the occasion to make "as profound an impression as possible upon the imagination" of the child in regard to "the facts of life and growth and death." With all she says of the importance of these conceptions, and the immense part they have played in the history of mankind, I entirely agree; but I should be very cautious about undertaking to introduce them into the mind of a child, while, with its lack of experience, it is still so dominated by imagination as not to know the difference between the true and the false among ideas. Mrs. Jacobi says, "The great fact of growth and incessant change in living organisms is perfectly appreciable through impressions made on his senses, and is well fitted to arouse in him lively interest and curiosity." If this be really so, then no more is needed than to furnish the child with his sprouting seeds as we both do. But surely mankind has been familiar enough with the sensible facts of germination, and yet the grossest errors concerning life-changes have prevailed through all past times. Indeed, Mrs. Jacobi quickly abandons this ground, that the child will perfectly appreciate the case, by saying it is "important to impress the imagination with typical and fundamental facts long before they can be reasoned upon or their laws really understood." I should prefer to let the child grow by slow preparation in concrete observations, till its mind gains knowledge and strength to understand typical and fundamental facts upon recondite subjects.

I gave my reasons for objecting to drawing as a means of acquiring descriptive botany. In her third proposition Mrs. Jacobi puts my view in this form: "That children should not be detained to draw the leaves, *or other natural objects they study*, because of the delay thus entailed." And, in commenting upon this, she further remarks: "If the aim at the time be *not to learn botany*, but to cultivate the observing powers of children, what danger is there in a delay which permits the object to be more deeply graven on the child's mind? Why is it so necessary to become familiar with hundreds of specimens *in a given time?*" As our object is here presumably to get at the truth, I have a right to insist upon greater correctness in the representation of my views. Mrs. Jacobi pleads to inaccuracy in her former statement of them in regard to drawing; but there are three further inaccuracies here, which I have indicated by italics, and, trivial as they may seem, they give an erroneous impression of my method. Without warrant, she introduces the phrase "other natural objects," so that a quite special objection to drawing in the endless field of observation which the study of plants presents, is generalized into opposition, on my part, to the use of natural objects as drawing-lessons. Nothing I have said can be construed into opposition to drawing, which of course has its uses; but it may also be misplaced and misused. Whenever the object is to form a habit through repetitions of a great number of simple exercises, the intrusion of such a mechanical operation as drawing must seriously hinder the work in hand. In arithmetic, for example, it is necessary to go through a great number of numerical exercises to form the habit of rapid and accurate calculation. But many of the problems involve concrete imagery which is capable of pictorial illustration. If, however, with a view of deepening his impressions, the pupil were required to make drawings of these, he would, to say the least, be very much obstructed in his mathematical progress.

Mrs. Jacobi puts it as if I had said my aim in preparing the "First Book" was not to teach botany, which is incorrect. Although the

"First Book" attempts to make a beginning only, yet it claims to begin right, and to teach botany as it should be taught, by making the mind thoroughly familiar with the actual characters of plants. Training in observation, for its mental advantages, was an accompanying purpose, because the conditions of the two perfectly coincide.

Again, in her question, "Why is it so necessary to become familiar with hundreds of specimens *in a given time?*" Mrs. Jacobi would commit me to the worst folly of current education—the time-limit in acquisition, or what may be called "fourteen-weeks" science. From the outset, and constantly, I have resisted this tendency, and have claimed that the fullest time should be taken as the first condition of real and permanent acquisition. As to the fourth proposition, I am quite content to leave it as it was presented in my article in the October Monthly.

Fifthly, and finally, Mrs. Jacobi ascribes to me as "an axiom that can not be disputed, that mental effort should advance from the simple subject to the more complex"; and she adds, that this proposition "is the one with which I most decidedly disagree." In arguing the point, Mrs. Jacobi maintains that the historic advance of knowledge has not always conformed to this principle. Very likely; but I have never said the law is everywhere observed. There are plenty of teachers who have not the slightest idea of it, and plenty of school-books which violate it, by putting the complex first, instead of leading up to it by simple steps. But where ideas are perfectly clear, as with the relations of number, experience enforces the principle; every arithmetic proceeds from the simple to the complex. All this, however, is aside from the question; my contention has been simply that the principle should not be violated in the mental cultivation of children. By the title of her first articles, "An Experiment in Primary Education," and the comments which followed, the difference between us related only to the mental conditions of childhood; but she here commits me to a statement concerning mental effort in general. Had she introduced the term *juvenile* to qualify "mental effort," she would have properly described the case, and made superfluous much that she says on the order of the evolution of knowledge. Assuming that there are stages in the progress of the individual mind, the question is as to the nature and educational significance of these successive stages, and what kind of study is appropriate at one stage and inappropriate at another. I see no way of getting light upon this matter and the practical points in issue, but by referring to the nature and constitution of the mind and the laws of mental growth. Mrs. Jacobi maintains that young children can profitably occupy their mind with things, facts, data, but are mentally unfit for the study of relations in which science consists; an examination of the part played by relations in mental structure and growth will therefore have an essential bearing upon this discussion.

The external world is made up of objects in relations with each other. Nothing exists by itself, or out of relation with other things. The very attributes which constitute a thing are its relations. The perceiving mind, on the other hand, is constituted to recognize relations. By these it identifies each thing. All objects are classed by their relations of likeness and unlikeness, and all knowledge is organized on this basis. To investigate a thing is but to determine its relations. Knowledge, in short, is relative, and our thinking is all carried on in terms of relation. The infinitely extended and the infinitely minute contexture of relations which constitutes the order of nature has for its counterpart a marvelous nervous mechanism constructed to reproduce these relations. The outer world, by its forces, acts upon the senses, producing myriads of sensations, diverse in quality and intensity, which are conveyed to the great central organ of mind, the brain. This consists of the simplest elements, cells and fibers, but there are hundreds of millions of these, closely knit and bound together by commissures, so as to produce a compactly unified organism, capable of duplicating in thought the multitudinous relations of the surrounding universe. Added to this, we have to view the brain as a creation of Nature through processes which have been going forward incessantly and continuously during vast periods of time. It has been slowly evolved by long intercourse with the environing world. It used to be thought that the mind begins with the new-born creature, and it was likened to a sheet of white paper, upon which anything can be scribbled. But it is now held that the central nervous organism at birth embodies a mass of nascent activities, latent capacities, and instinctive impulses which have been inherited from ancestral generations through the experience of the race, and in which the correspondence between the relations of external phenomena and the internal relations of the mind has been progressively increasing in extent and complexity. If, now, we glance at the early processes of the unfolding mind, we shall see that this matter of relations and their classing is very deep in the mental constitution. Mind is made up of three distinct elements, the power to feel, the power to act, and the power to know, or emotion, will, and intellect. Of these, feeling is primordial, and leads to action and to knowing. At first there is only feeling; but changes of feeling arise as soon as external forces begin to act upon the susceptible infant organism. These changes of feeling are the raw material which is to be wrought into distinct consciousness. A change of feeling supplies two terms and a relation, and the discrimination of these is the earliest act of knowing. The baby cries when in pain, and sleeps sweetly when all goes well with it. Thus at the very dawn of psychical life there are established relations of likeness and unlikeness among feelings by which they are organically classed as feelings of comfort and discomfort, pleasures and pains. Discrimination of relations is thus the very germ of intelligence. Through its apparatus of sensibility, known as the special senses, external impulses are conveyed to the brain, light through the optical channel, sounds through the auditory nerve. But at first visible things are not seen nor sounds heard. It is only by numberless repetitions of like sensations that an impression is at length produced. Like sensations are gradually integrated until perceptions arise. As we trace onward the process by which sensations become perceptions and perceptions grow to conceptions, we find that all orders of ideas are built up out of the states of consciousness produced in us by things and their relations. As I wrote, fifteen years ago: We know things because, when we see, hear, touch, or taste them, the present impression spontaneously blends with like impressions before experienced. We know or recognize an external object, not by the single impression it produces, but because that impression revives a whole train or group of previous discriminations that are like or related to it. If something is seen, heard, felt, or tasted, which links itself to no kindred idea, we say, "We do not know it"; if it partially agrees with an idea, or revives a few discriminations, we know something about it, and the completer the agreement the more perfect the knowledge. As to know a thing is to perceive its differences from other things and its likeness to other things, it is strictly an act of *classing*. This is involved in every act of thought, for to recognize a thing is to class its impression or idea with previous states of feeling. Classification in all its aspects and applications is but the putting together of things that are alike—the grouping of objects by their resemblances; and as to know a thing is to know that it is like *this* or *that*, to know what it is like and what it is unlike we begin to classify as soon as we begin to think.

In early infancy, when the mind is first making the acquaintance of outward things, mental growth consists essentially in the production of *new ideas* by means of repetitions of sense-impressions, and in this process the pre-established relations among the cells and fibers of the brain are of the greatest possible moment. The organized and semi-organized groups of relations among the cerebral elements can give no knowledge until the special groups of relations to which they correspond have been presented to the consciousness by means of the child's daily and hourly experience of objects and activities. The attributes of size, color, weight, transparency, roughness, hardness, fluidity, warmth, taste, and various other properties of solid and liquid substances, and the aspects of people and domestic animals, are noted. Ideas of all the common objects of the house, the grounds, the walks, the drives, are soon formed and associated with words that denote them. Through its spontaneous activity it has hit upon those special co-ordinations of movement required in creeping, walking, holding things, and the like, which have greatly aided in enlarging its knowledge, so that, at the end of a few months, it has a store of complex conceptions, and has acquired numerous aptitudes and dexterities. Hence its early ideas never arise singly, but are linked together in their origin; groups of ideas are integrated into trains of thought, and words into corresponding trains of sentences to express them. When a stock of ideas has been formed in this manner, the mental growth is mainly carried forward by the establishment of new combinations among them. The simpler ideas pertaining to the objects and actions of the child's environment being once acquired, the development of intelligence consists largely in associating them in new relations and groups of relations. The perception of likeness and difference is the essential work that is going on all the time, but the comparisons and discriminations are constantly becoming more extensive, more complex, more minute, and more accurate. Thus elementary ideas become fused into one complex idea; by a still further recognition of likeness and difference, this is associated with a new group, and this again with still larger clusters of associated ideas.

"That which occurs at this earliest stage of mental growth is exactly what takes place in the whole course of unfolding intelligence. Simple as these operations may seem, and begun by the infant as soon as it is born, in their growing complexities they constitute the whole fabric of the intellect. What we call the "mental faculties" are only different modes of the mental activity; and as one law of growth evolves all the various organs and tissues of the bodily structure, so one law of growth evolves all the diversified "faculties" of the mental structure. Under psychological analysis, the operations of reason, judgment, imagination, calculation, and the acquisitions of the most advanced minds yield at last the same simple elements—the perceptions of likenesses and differences among things thought about; while memory is simply the power of reviving these distinctions in consciousness. Whatever the object of thought, to know in what respects it differs from all other things, and in what respects it resembles them, is to know all about it—is to exhaust the action of the intellect upon it. The way the child gets its early knowledge is the way all real knowledge is obtained. When it discovers the likeness between sugar, cake, and certain fruits, that is, when it groups them in thought as *sweet*, it is making just such an induction as Newton made in discovering the law of gravitation, which was but to discover the likeness among celestial and terrestrial motions. And as with physical objects, so also with human actions. The child *may* run around the house and play with its toys, but it *must not* break things or play with fire. Here, again, are relations of likeness and unlikeness, forming a basis of moral classification. The judge on the bench is constantly doing the same thing; that is, tracing out the likenesses of given actions, and classing them as right and wrong." *

We hence see that by necessity and by the very nature of intelligence the movements of mental growth are from the relatively simple

* Essay on "The Cultivation of the Observing Powers of Children." (1870.)

to the relatively complex. The whole process is one of building simpler elements into more complicated relations, and it goes on just the same in the minds of children as of adults. The increase of knowledge, the increase of faculty, the increase of mental power, all resolve themselves into a finer discrimination, a greater clearness of perception, and a wider grasp of the relations among objects of thought. The mind can not be worked backward because its processes are organically determined; and every step of increasing intelligence is a step of increasing complication. These considerations are decisive as to the main issue of the present controversy.

Mrs. Jacobi repeatedly affirms a "pre-scientific stage" of mental development; and her whole case depends upon the validity of this position, and what she means by it. She indicates her idea of what it is by saying: "Scientific observation is observation of the relations between things; but before any attempt be made to study these relations the things themselves should be firmly and clearly apprehended." But it has been shown that this is not possible. Neither children nor anybody else can apprehend things apart from their relations; they know them either vaguely or clearly, partially or fully, only by perceiving their relations. Mrs. Jacobi's distinguishing mark of the "pre-scientific stage" thus disappears, and all the reasoning by which she would put off the study of plants in their relations, or with a view to classification to a late period of study, falls to the ground. She says, "The comparison of a multitude of objects in order to abstract their common character, and thus obtain the generic or class conception, is suited to the scientific but not to the pre-scientific stage of progress." The only meaning that can be given to this statement is that there are stages of classification too complex for children at the outset of study; but it is a grave error to suppose that the properly guided pupil is to come suddenly upon the formidable work of classification as a new task. The child has been classing things from its birth, and in its earliest observations upon the simplest parts of plants it enters upon an easy stage of classification, and it is through these exercises that the higher work is gradually reached. The process is continuous. The child from the first has been comparing objects and abstracting their common characters. It matters nothing that at first this action is automatic; it leads to conscious classing and is of the same nature with it. Progress in the formation of such general ideas as chair, cat, dog, may be clearly seen by the intelligent observer to consist in the comparison of the members of all such groups of objects and an abstraction of their common characters. Of course, this work is imperfect at first. The failures of children in forming correct general notions of some complexity was well illustrated by a little boy under three years of age, when his sympathies were appealed to in behalf of the cat he was teasing by the statement that he too was an animal. This he indignantly repelled, and, springing to his feet, he caught the skirt of his dress and extending it toward me exclaimed, "See there, I'm *not* an animal!" Absence of clothing was thus a common character which he had generalized into the conception of an animal.

But if the essential mental processes are exactly the same in nature from first to last, in what then does science consist, and where is it to begin? There is a current notion that science is something different from common knowledge—something especially difficult to be injected late in courses of study; and Mrs. Jacobi seems to countenance this view. But we have seen that the process of thought is the same in common knowledge as in science. The difference between them is simply this, that the perceptions of relations in ordinary knowledge are loose, vague, and inaccurate, while it is the office of science to make them more careful, clear, and exact. It is simply a question of degree, and we must assume that science begins at the point where the teacher intervenes to guide the mental processes of the child, and make them more accurate and truthful. This work should be commenced sooner than has been generally supposed; and the view that the rudiments of all science are contained in the common knowledge possessed by the child necessitates a much earlier cultivation of the observing powers of children than is currently practiced. To prevent the break which commonly occurs when children enter upon the study of books and begin to substitute words for things, and to continue the processes which Nature has initiated, I sought for the simplest objects by which connected observations can be pursued, and the work of comparing, tracing out relations, and classifying can be continued, and for this purpose the simpler parts of plants are well adapted. Little children have already a large stock of ideas of the relations of concrete things. They know leaves, and stems, and flowers, though in a loose and indefinite way. The first effect of careful observation is to make these ideas more definite and precise. For instance, in place of the vague notion of leaves formed from casual acquaintance with them, the examination of a variety of leaf-forms reveals distinctly different kinds of leaves accordingly as they are made up of blade, stem, and stipule; of blade and stem; or of blade only. And each of these three definite classes receives a name with an equally definite meaning. On further observation, the blade turns out to be made up of different parts, which are to be further studied; the process of discovery and of precise naming goes on till leaves of all sorts fall into a few distinct groups, based upon definite characters and the simple recognition of these groups suffices for the beginning of classification. In the same way, from observation of stems, these fall into groups as round, square, erect, trailing, creeping, etc. Closer observation reveals still minuter characters, and the numerous individuals to be examined and described insure the repetition needful to depth and retention of impressions. In the objective study of plants the intellectual operations range from the simplest recognition of obvious likeness and difference among leaves, stems, flowers, etc., to the perception of contrasts and resemblances among multitudes of plants, by which they are separated into genera, tribes, orders, classes, series, and various intermediate groups. But here, as everywhere, the simple leads to the complex. The limits of these groups are determined by the presence or absence of features that have been made familiar in the course of earlier study.

By the title of her article Mrs. Jacobi gives prominence to the question of precedence between the leaf and the flower with reference to the plan of my little text-book. Obviously a school-book can only imperfectly conform to the various grades of capacity it addresses. If its aim is to reach the lowest grade that can begin the work of systematic and accurate observation ; and if, as the result of experience in the present case, it has been found that there is a stage of child-life when the attention may be successfully given to the study of leaf-characters, and can not be so held to the study of the flower, it would seem reasonable that the leaf should come first in the order of study. But one might not need to follow the same order with a child ten years old as with a child of six, because the former has greater capacity, and can do what the latter can not. An average child of ten years might perhaps begin observation anywhere, so far as his ability is concerned, while with an average child of five or six this could not be done. As stated in my previous article, it was necessary to begin somewhere, and the book is therefore apparently rigid in method ; but I have repeatedly recommended in it that teachers exercise judgment, and skip about and choose what is most timely and appropriate to the circumstances and varying capacity of their pupils. Of course, for those teachers who think it a duty in all cases to begin at the beginning and go straight to the end, there is no help.

If, as in the present case, the dominant idea be that of self-education, if the pupil is to do his own thinking and discovering with the least possible guidance, it will be abundantly found that a young child will do this pleasurably and profitably with leaves before he can do it with flowers ; for, in the case of the leaf, the mind passes more gradually from the looseness of common observation and language to the carefulness and accuracy required in the initiation of scientific study. The parts to be at first noted are more differentiated and fewer, and the number of new precise terms to mark them is smaller, and these may hence be firmly associated with the objects before fresh ones are brought forward. And, even if the method of study be purely instructional, if we point out the characters of the object to the child, and explain all about it, while he passively looks on and remembers what he may, we shall still find that the similarity and number of the different parts of the flower, and the cluster of new terms that at once crowd upon the attention, confuse and hinder, if they do not positively repel, these youngest beginners.

AGATIZED AND JASPERIZED WOOD OF ARIZONA.

By GEORGE F. KUNZ.

UNDOUBTEDLY one of the greatest of American wonders is the silicified forest in Arizona, known as Chalcedony Park—a park only in name, however, for the giant trees which once grew there have long since fallen and silicified into agate and jasper. It is situated eight miles south of Corriza, a station on the Atlantic and Pacific Railroad, in Apache County, Arizona, twenty-four miles southeast of Holbrook. This marvelous deposit of probably a million tons of silicified trees covers a thousand acres. The wood is generally found projecting from the volcanic ash and lava, which is covered with sandstone to the depth of from twenty to thirty feet, and lies exposed in the gulches and basins where the water has worn away the sandstone.

The silicification probably took place in the following manner: The trees were overthrown and covered with volcanic ashes and tufa, the heated silicified waters, either gushing from springs or forced up by the violent volcanic action which felled the trees, percolated through the ashes, cooled on reaching the tree-level, and thus produced conditions favorable to silicification.

The moisture in the tufa may have effected a partial alteration, as also any waters that may have filtrated through it from rains or springs either hot or cold. Under these circumstances decomposition would be assisted and much silica be set free. The waters would become charged with this, the silica being held partly in solution similar to that in liquid glass, the silicate of soda of commerce. The silicious water then slowly penetrated the wood buried in the tufa and was slowly deposited in the cells of the wood. In this manner the fibers of the wood were replaced by the silica. The process was evidently a slow one, and the trees, from all appearances, were partly decayed and water-logged when the silicification took place. The jasper and agate generally replaced the cell-walls and fibers, and the transparent quartz filled the cells and interstices, especially where the structure was broken down by decay. These cell-centers and cavities produced the conditions favorable not only for the deposition of the silica as quartz, but also for the formation of the drusy, crystalline cavities of quartz and amethyst that enhance the beauty of the material so much. It is evident, from the rich variety of colors, that the waters held oxides of iron and perhaps manganese, as well as silica, the red color being caused by hematite, the yellows and browns by limonite, and the black by oxides of manganese.

It is possible also that the ash was deposited partly in water and thus heated it. There is every indication that the deposit is of con-

"CHALCEDONY PARK," LOOKING NORTH.

siderable depth. Over the entire area the trees lie scattered in all conceivable positions and in fragments of all sizes, sometimes resembling a pile of cart-wheels. A tree one hundred and fifty feet in length is often found broken up into as many sections of almost uniform length, presenting the appearance of having been sawed asunder for shingle-blocks by some prehistoric forester.

Again, we find a giant tree broken into countless fragments, ranging in size from a small pebble to a fair-sized bowlder. Perfect-shaped cubes, ready to be polished and used for paper-weights, are also found. These multiplied fractures are the result of alternate heat and cold acting on the water collected in the fissures of the tree.

The highest point in the park is some two hundred feet above the surrounding level, and it is here that the buried trees can be seen to the best advantage. Some of them are one hundred and fifty feet long and ten feet in diameter, and lie exposed in all conceivable positions. One section of a tree, which has been broken up, measures eight feet in diameter, ten feet in length, and weighs several tons. The tree was originally about two hundred feet long. Some pieces of the trunks of these trees, which were brought to New York, ranged from eight inches to three feet in diameter, and from twenty-five to one thousand pounds in weight. The perfect preservation of these trunks is remarkable. The rings are so distinctly visible as to convince even the most incredulous of their organic origin.

The most interesting points in the park have been suggestively named, The Agate or Natural Bridge, Agate Gulch, Amethyst Point, Fort Jasper, etc.

The most remarkable feature of the park, and a phenomenon perhaps unparalleled, is the Natural Bridge, of agatized wood, formed by a tree, spanning a cañon forty-five feet in depth and fifty-five in width. In addition to the span, fully fifty feet of the tree rests on one side, making the tree visible for a length of over one hundred feet. Both ends of the tree are imbedded in the sandstone. It averages three and a half feet in diameter, four feet at the thickest part, and three at the smallest. Where the bark does not adhere, the characteristic colors of jasper and agate are to be seen.

Although silicified wood is found in many localities throughout the world, nowhere is it so beautifully colored as at this place. Here we have every imaginable shade of red, yellow, brown, and green. Sometimes the colors appear in distinct spots, forming a mottled appearance ; then, again, all blend so imperceptibly as to make a much more pleasing and harmonious effect than the decided banding of the agate, where the lines of demarkation between the colors are so distinct as to become obtrusive. The colors above mentioned are often relieved by white, black, and gray, and by transparent spaces of brilliant quartz-crystals, or—as sometimes occurs—of amethyst.

Broken sections of the hollow trunks are often lined with amethyst, quartz, and calcite, which add their brilliancy to the endless variety of color.

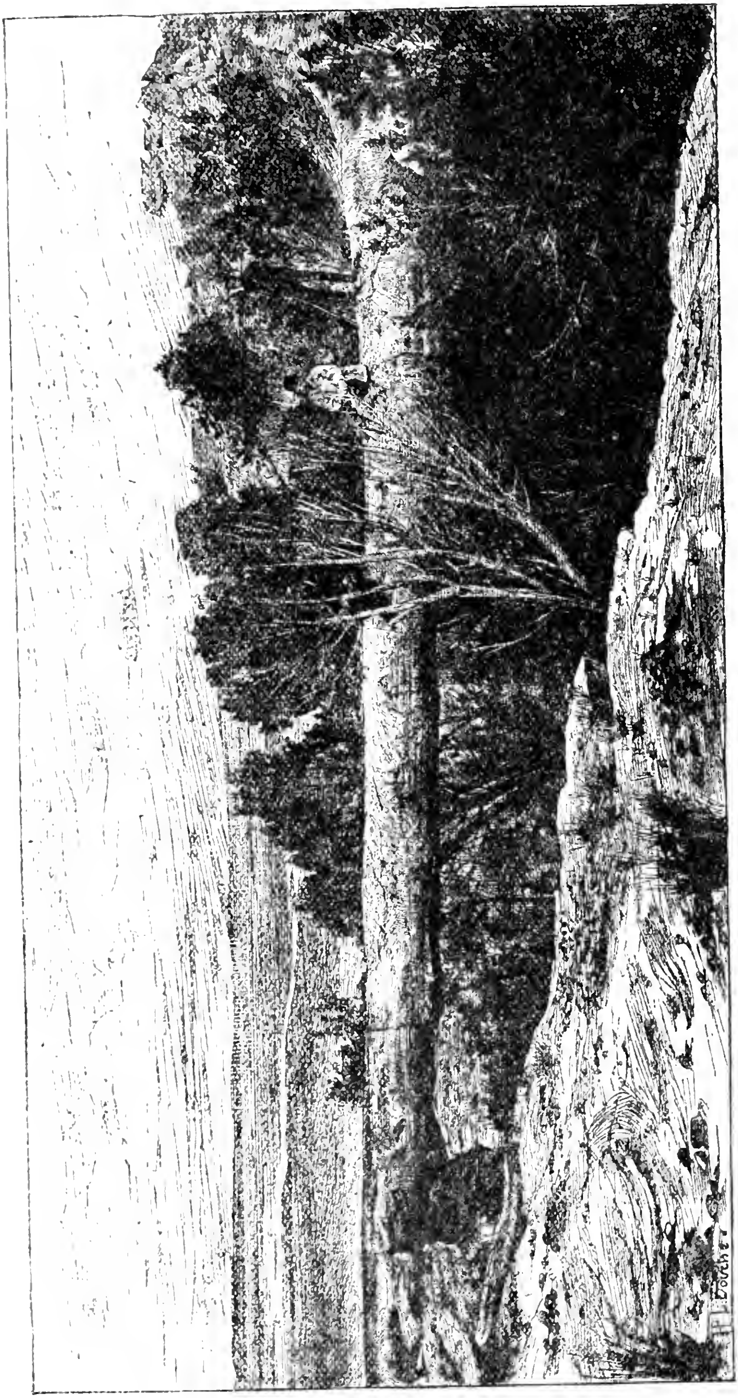
Beautiful as the wood is to the naked eye, a microscope is needed to reveal its true beauty. Not only does the glass enhance the colors, but it also renders visible the structure, which has been perfectly preserved even to the forms of the minute cells, and is more beautiful now than before the transformation.

Dr. P. H. Dudley, of New York, microscopically examined some sections of this wood, and finds that part of it at least belongs to the genus *Araucaria*. He says that the *Araucaria excelsa*, the Norfolk Island pine of the South Pacific Ocean, grows to a height of from one hundred and fifty to two hundred feet. In radical longitudinal section, the lenticular markings on the wood-cells near each end are in double rows and contiguous, the markings of one row alternating with those of the other, giving the appearance of the beautiful hexagonal markings of this genus. In central portions of the cells sometimes only one row of markings is seen, and some cells show only one row. Medullary rays were indistinct.

Other portions resembled our red cedar (*Juniperus Virginianus*) when grown in the extreme South. The cell-structure of some indicates a growth in a mild and uniform climate, the annular rings being marked only by one, two, three, or more, slightly smaller hexagonal or rounded cells, not tabular, as is usually the case. The cell-walls were nearly uniform in thickness. All the specimens examined showed that the wood originally was undergoing decay before being filled with the various media which afterward solidified. On some of the specimens traces of fungi (*mycelium*), causing decay, were discovered. The beauty of the wood is largely due to the destructive influence of fungi.

Agate-cutting has been carried on as an industry for over three hundred years, in the Oberstein district, in Germany, but little attention has been paid heretofore to the cutting of large masses, because few agates are found over a foot in diameter, and the banding is not such as to offer much inducement. But in the future this material will doubtless be in great demand for interior house-decoration, where it can be advantageously used as inlays in wood or stone; for paneling and wainscoting walls; for tiling; and, if desired, for entire floors. Whole table-tops could be made of the largest size from a single section of one of these giant trees, and the design would be Nature's own incomparable handiwork. For mosaic-work it would also find a ready use, since the infinite diversity of color would afford an ample field for the imagination of the skillful artisans employed at this industry.

The rich, warm, blending colors, and the remarkable polish that this material is susceptible of, are the main features that will always give it a high place among minerals of its class. In fact, it is a ques-



NATURAL BRIDGE OF AGATIZED WOOD.

tion whether any of the ornamental stones, such as jade, jasper, agate, or even the marbles, have the two desired qualities to such a degree.

As before stated, the deposit has been estimated at a million tons, but probably not more than a thousand tons would be suitable for the purposes of art, while for finer work only a small part of this would be available. One instance should be noted to show the high estimation in which this wood is held by foreigners. A Russian dealer recently paid five hundred dollars for a piece twenty-eight inches in diameter and thirty inches in length, to be cut into table-tops. A large lot was recently sent abroad for cutting, and we shall soon have a new decorative stone which will possess what very few now in use do —the proper hardness.

A piece of this material was selected by Mr. Joseph Pulitzer, to form the base for the beautiful silver center-piece, which is being made by Messrs Tiffany & C., to be given as a testimonial to the eminent sculptor, F. A. Bartholdi. This base is a low truncated pyramid, eleven inches square at the base, nine inches at the top, and seven and half inches high, and is made of a single section of a tree. It was chosen on account of its superior hardness and the warmth and pleasing combination of its colors. Besides, as the designer remarked, it is eminently fitting that the testimonial should rest "on a solid American base."

This is the largest piece of such hard material that has ever been cut into a definite shape in the United States.

One of the recent freaks of fashion has been the revival of the old Scotch jewelry. The leading objection to this is the stiffness of the designs. These have in many instances, however, been Americanized and improved upon; the tame, uninteresting bloodstones and agates giving place to our own richer and brighter stones and silicified woods.

NONCONFORMITY.*

By HERBERT SPENCER.

NOTHING like that which we now call Nonconformity can be traced in societies of simple types. Devoid of the knowledge and the mental tendencies which lead to criticism and scepticism, the savage passively accepts whatever his seniors assert. Custom in the form of established belief, as well as in the form of established usage, is sacred with him: dissent from it is unheard of. And throughout long early stages of social evolution there continues, among results of this trait, the adhesion to inherited religions. It is true that during these stages numerous cults co-exist side by side; but, products as these are of the prevailing ancestor-worship, the resulting polytheism does not show

* From "Ecclesiastical Institutions," in the press of D. Appleton & Co.

us what we now understand as Nonconformity; since the devotees at the various shrines neither deny one another's gods, nor call in question in pronounced ways the current ideas concerning them. Only in cases like that of Socrates, who enunciated a conception of supernatural agents diverging widely from the popular conception of them, do we see in early societies Nonconformity properly so-called.

What we have here to deal with under this name occurs chiefly in societies which are substantially, if not literally, monotheistic; and in which there exists nominally, if not really, a tolerably uniform creed administered by a consolidated hierarchy.

Even as thus restricted, Nonconformity comprehends phenomena widely unlike in their natures; and that we may understand it, we must exclude much that is allied with it only by outward form and circumstance. Though in most cases a separating sect espouses some unauthorized version of the accepted creed; and though the nature of the espoused version is occasionally not without its significance; yet the thing specially to be noted is the attitude assumed toward ecclesiastical government. Though there is always some exercise of individual judgment; yet in early stages this is shown merely in the choice of one authority as superior to another. Only in late stages does there come an exercise of individual judgment which goes to the extent of denying ecclesiastical authority in general.

The growth of this later attitude we shall see on comparing some of the successive stages.

Ancient forms of dissent habitually stand for the authority of the past over the present; and since tradition usually brings from more barbarous ages accounts of more barbarous modes of propitiation, ancient forms of dissent are habitually revivals of practices more ascetic than those of the current religion. It was shown in § 620, that the primitive monachism originated in this way; and as Christianity, with the higher moral precepts on which it insisted, joined renunciation of ordinary life and its aims (said to be derived from the Essenes), there tended to be thereafter a continual re-genesis of dissenting sects characterized in common by austerities.

Kinds of dissent differing from these and differing from modern kinds of dissent, arose during those times in which the early church was spreading and becoming organized. For before ecclesiastical government had established itself and acquired sacredness, resistance to each new encroachment made by it, naturally led to divisions. Between the time when the authority dwelt in the Christian congregations themselves, and the time when the authority was centred in the pope, there necessarily went successive usurpations of authority, each of which gave occasion for protest. Hence, such sects, arising in the third century and onward to the seventh century, as the Noetians, Novatians, Meletians, Aerians, Donatists, Joannites, Haesitantes, Timotheans, and Athingani.

Passing over that period during which ecclesiastical power throughout Europe was rising to its climax, we come, in the twelfth century, to dissenters of more advanced types; who, with or without differences of doctrine, rebelled against the then-existing church government. Such sects as the Arnoldists in Italy, the Petrobrusians, Caputiati and Waldenses in France, and afterward the Stedingers in Germany and the Apostolicals in Italy, are examples; severally characterized by assertion of individual freedom, alike in judgment and action. Ordinarily holding doctrines called heretical, the promulgation of which was itself a tacit denial of ecclesiastical authority (though a denial habitually based on submission to an alleged higher authority), sects of this kind went on increasing in the fourteenth and fifteenth centuries. There were the Lollards in England; the Fraticelli in Italy; the Taborites, Bohemian Brethren, Moravians and Hussites, in Bohemia: all setting themselves against church-discipline. And then the rebellious movement of the reformation, as carried forward by the Lutherans in Germany, the Zwinglians and Calvinists in Switzerland, the Huguenots in France, the Anabaptists and Presbyterians in England, exhibited, along with repudiation of various established doctrines, ceremonies, and usages, a more pronounced anti-sacerdotalism. Characterized in common by opposition to Episcopacy, protestant or catholic, we see first of all in the government by presbyters, adopted by sundry of these dissenting bodies, a step toward freedom of judgment and practice in religious matters, accompanied by denial of priestly inspiration. And then in the subsequent rise of the Independents, taking for their distinctive principle the right of each congregation to govern itself, we see a further advance in that anti-sacerdotal movement which reached its extreme in the next century with the Quakers; who, going directly to the fountain head of the creed, and carrying out more consistently than usual the professed right of private judgment, repudiated the entire paraphernalia of ecclesiasticism.

It is true that the histories of these various non-conforming bodies, not excluding even the Society of Friends, show us the re-growth of a coercive rule, allied to that against which there had been rebellion. Of religious revolutions, as of political revolutions, it is true that in the absence of differences of character and culture greater than can be expected in the same society at the same time, they are followed by gradually established forms of rule only in some degree better than those diverged from. In his assumption of infallibility, and his measures for enforcing conformity, Calvin was a pope comparable with any who issued bulls from the Vatican. The discipline of the Scottish Presbyterians was as despotic, as rigorous, and as relentless as any which Catholicism had enforced. The Puritans of New England were as positive in their dogmas, and as severe in their persecutions, as were the ecclesiastics of the church they left behind. Some of these dissenting bodies, indeed, as the Wesleyans, have developed organizations scarcely less priestly, and, in some respects, more coercive, than the organization of the church from which they diverged. Even among the Quakers, notwithstanding the pronounced individuality implied by their theory, there has grown up a definite creed and a body exercising control.

Modern Nonconformity in England has much more decidedly exhibited the essential trait of anti-sacerdotalism. It has done this in various minor ways as well as in a major way.

There is the multiplication of sects, with which by foreign observers England is reproached, but which, philosophically considered, is one of her superior traits. For the rise of every new sect, implying a re-assertion of the right of private judgment, is a collateral result of the nature which makes free institutions possible.

Still more significant do we see this multiplication of sects to be if we consider the assigned causes of division. Take, for instance, the case of the Wesleyans. In 1797 the Methodist New Connexion organized itself on the principle of lay participation in church government. In 1810 the Primitive Methodists left the original body: the cause being a desire to have "lay representatives to the Conference." Again, in 1834, prompted by opposition to priestly power, the Wesleyan Methodist Association was formed: its members claiming more influence for the laity, and resisting central interference with local government. And then in 1849, there was yet another secession from the Methodist body, similarly characterized by resistance to ministerial authority.

Of course, in sects less coercively governed, there have been fewer occasions for rebellions against priestly control; but there are not wanting illustrations, some of them supplied even by the small and free bodies of the Unitarians, of this tendency to divide in pursuance of the right of private judgment. Moreover, in the absence of a dissidence sufficiently great to produce secession, there is everywhere a large amount of express disagreement on minor points among those holding what is supposed to be the same body of beliefs. Perhaps the most curious instance of this is furnished by the established Church. I do not refer simply to its divisions into high, and low, and broad; all implying more or less of the nonconforming spirit within it. I refer more especially to the strange anomaly that the ritualists are men who, while asserting priestly authority, are themselves rebels against priestly authority—defy their ecclesiastical superiors in their determination to assert ecclesiastical supremacy.

But the universally admitted claim to religious freedom shown in these various ways, is shown still more by the growing movement for disestablishment of the Church. This movement, which, besides tacitly denying all sacerdotal authority, denies the power of a government, even though elected by a majority of votes, to prescribe religious belief or practice, is the logical outcome of the Protestant theory.

Liberty of thought, long asserted and more and more displayed, is about to be carried to the extent that no man shall be constrained to support another man's creed.

Evidently the arrival at this state completes that social differentiation which began when the primitive chief first deputed his priestly function.

As implied in the last sentence, the changes above sketched out are concomitants of the changes sketched out in the last chapter. The prolonged conflict between Church and State accompanying their differentiation, and ending in the subordination of the Church, has been accompanied by these collateral minor conflicts between the Church and recalcitrant portions of its members, ending in separation of them.

There is a further implication. In common with the subjection of the Church to the State, the spread of Nonconformity is an indirect result of growing industrialism. The moral nature proper to a social organization based on contract instead of *status*—the moral nature fostered by a social life carried on under voluntary co-operation instead of compulsory co-operation, is one which works out religious independence as it works out political freedom. And this conclusion, manifest *a priori*, is verified *a posteriori* in sundry ways. We see that Nonconformity, increasing as industrialism has developed, now characterizes in the greatest degree those nations which are most characterized by development of the industrial type—America and England. And we also see that in England itself, the contrast between urban and rural populations, as well as the contrast between populations in different parts of the kingdom, show that where the industrial type of life and organization predominates, Nonconformity is the most pronounced.

A NEW FIELD OF AMERICAN HISTORY.

WE have hitherto been accustomed to treat the history of the United States as consisting primarily of the history of the Atlantic portion. When it has become necessary in the progress of the review to advert to the history of other parts of the continent, the subject has been considered as related to the history of the Eastern States, and subordinated to it. This may have been proper so long as the historical nation lay east of the Mississippi River, but when Louisiana was bought we took in a region with an independent history of its own; when the question of the title to Oregon was agitated, an historical inquiry in a new direction became of great importance to us; and when California was acquired we came into possession of still another history, antedating that of our original States by a hundred years, and unexcelled in its fullness of romance and adventure.

Still, the making of our text-books and new histories has been going on with the Atlantic States marking the beginnings and the Pacific domain introduced as a product of the present century, with a mere reference to its three hundred years of romantic past. For any notices of that we must go to books about Mexico, to find very little of it there. Some of the earliest and most interesting developments of the history of the country as we now know it were worked out on the Pacific coast; but their story was hidden in masses of documents and loose records that were inaccessible to ordinary historians till Mr. Hubert H. Bancroft unearthed them for presentation in solid form in his "History of the Pacific States of North America."

This history, when completed, will fill thirty-nine volumes, of which eighteen have now been published. It consists of two series, of which the first series, published ten years ago in five volumes, gives all that was known at that time of the native races. As there has been some discussion, and it is growing more lively, about the theories of these races, and the author's position in the matter has been brought into question, it is proper to say here that he disavows having anything to do with theories or the solution of disputed questions. His purpose has simply been to collect all the material that is worthy of notice, and put it where it will be accessible, making only such critical observations as suggest themselves in course, leaving closer special investigations to future students. The richness of the material he has provided and put here, in the hands of such investigators, can not fail to be of great help to them. Without it they might have to work for years to secure a position of knowledge available for comparative research, where they now find themselves at the start.

The first two of the volumes on the native races are devoted to the ethnographical description of the tribes; the third to their myths and language; the fourth to their antiquities; and the fifth to their primitive history. The tribes are classified, for convenience of treatment rather than to conform to a scientifically accurate standard, into geographical groups, as Hyperboreans, those natives whose territory lies north of the fifty-fifth parallel; Columbians, between the fifty-fifth and forty-second parallels, and mainly in the valley of the Columbia and its tributaries; Californians and the inhabitants of the Great Basin, New Mexicans, Wild Tribes of Mexico, Wild Tribes of Central America, and Civilized Natives of Mexico and Central America, the last having a volume to themselves. In these descriptions the author aims to portray such customs and characteristics as were peculiar to each people at the time of its first intercourse with European strangers, leaving scientific inquirers to make their own deductions. Much of the ground covered by the accounts has been gone over in later years by the new school of American ethnologists, whose observations have been fully published by the Government bureaus and various archæological societies, and have added considerably to what Mr. Bancroft was able to tell when he wrote, or have modified its bearing. In cases where they seem to contradict his authorities, the question is in place whether it is a rule that observations on Indians, after they have been for two or three hundred years in contact with white men, are more accurate as to what they were primarily than the accounts of those who saw them uncontaminated, even though their methods may not have been so closely trimmed to the scientific rule. In reading the rapid sketches of the characteristics of these people, we are struck by many suggestive points. Some force the thought that there is in the lowest of them something that tends to lift them above their usual level; some remind us how much alike are men, even in the most diverse conditions and places and ages; and some that the doctrine of evolution is not wholly a conception of civilized philosophy or the product of the thought of ages. How different from their usual life is that feeling that prompts the Central Californian Indians, who appear to be the old "diggers," and who live in bestial laziness, to such a regard for the woodpecker that they will not touch its property of stored acorns till they are driven to it by the extreme of hunger!

A remarkable contrast is afforded by two tribes living close to one another in New Mexico: the Apaches, who have a regular system of numeration, with a name for every number up to ten thousand; and the Comanches, who can not count further than their fingers or some other visible objects will carry them, and can not calculate at all.

The Indians of Zacatecas have a ceremony corresponding with that of the "blood-covenant," which is characteristic of the south Slavic nations in Europe, and is found among many Eastern and African peoples.

In the legend of the Indians of Mount Shasta, which describes the descent of man from a family of grizzly bears, who were somewhat different then from what they are at present, walking on their hind-legs like men, talking, and carrying clubs in their fore-limbs; in the Aht myth, which traces man's descent from the essences or embryos residing in them which the animals left behind when they fled from the sight of two beings in the shape of men; and in other stories of origins, we have glimpses of a kind of primitive doctrine of evolution. There are also stories teaching an inverse evolution, or the doctrine of degeneracy, in the descent of beasts, fishes, and even edible roots from human originals. Most curious is the Mexican doctrine of the future state and the wanderings of the spirit, which, except that the journey is briefer and the perils are correspondingly less numerous, might have been extracted from the Egyptian "Book of the Dead."

On this subject, and respecting the languages of these people, after having presented and compared them, the author says: "He who carefully examines the myths and languages of the aboriginal nations of the Pacific States can not fail to be impressed with the similarity between them and the beliefs and tongues of mankind elsewhere. Here is the same insatiate thirst to know the unknowable, here are the same audacious attempts to tear asunder the veil, the same fashioning and peopling of worlds, laying out and circumscribing of celestial regions, and manufacturing, and setting up, spiritually and materially, of creators, man, and animal-makers and rulers, everywhere manifest. Here is apparent what would seem to be the same inherent necessity for worship, for propitiation, for purification, or a cleansing from sin, for atonement and sacrifice, with all the symbols and paraphernalia of natural and artificial religion. In their speech the same grammatical constructions are seen with the usual variations in form and scope, in poverty and richness, which are found in nations, rude or cultivated, everywhere. Little as we know of the beginning and end of things, we can but feel, as fresh facts are brought to light and new comparisons made between the races and ages of the earth, that humanity, of whatsoever origin it may be or howsoever circumstanced, is formed on one model, and unfolds under the influence of an inspiration."

The second series, beginning with Volume VI, counting the whole work, will comprise the history of the several States under white dominion. Three volumes, when completed, will be devoted to Central America; six to Mexico; two to the North Mexican States and Texas; one to Arizona and New Mexico; seven to California; one to Nevada, Wyoming, and Colorado; one to Utah; two each to the Northwest Coast and Oregon; one to Washington, Idaho, and Montana; one each to British Columbia and Alaska; one to "California Pastoral," or its life and society before the discovery of gold; and one to "California Interpocula," or during the gold-mining epoch; two to "Popular Tribunals," or lynch-law and vigilance committees; and two will be of a miscellaneous character. The latest published volume, the twentieth in the order of numbering, which follows the geographical arrangement, or the eighteenth in the order of publication, which is according to the chronology, is the third of the history of California, and relates the story of that region as a "Territory under the Mexican Republic," from 1825 to 1840. The facts, mostly political, military, and financial in their bearing, are presented in a clear and satisfactory manner, so as to give those who are interested in those lines of development a connected view of their course, both in the territory as a whole, and in its several districts. The secularization of the church missions, which was largely accomplished during this period, and its immediate results, present interesting phases of social development worthy of the attention of the student of that subject. The incursions of foreigners, which have eventually revolutionized the aspect and the fate of the whole region, are traced back to their beginnings in individual visits from abroad which were often accidental, generally transient, and nearly always precarious; for the powers that ruled in those days were disposed to regard strangers much as they would wild beasts. For forty years, California had been visited with increasing frequency by foreigners, or persons whose blood was neither Indian nor Spanish. England, the United States, Russia, and France were the nations chiefly represented. "All had come from the South, or West, or North, by the broad highway of the Pacific Ocean, bounding the territory on the west, and leading to within a few miles of the most inland Spanish settlements." The inland boundary—an arc for the most part of *sierras nevadas* so far as could be seen, with a zone of desert beyond still unknown—had never yet been crossed by man of foreign race, nor trod, if we except the southern segment cut by a line from San Gabriel to Mojave, by other than aboriginal feet. The "grand advance movement" of fur-hunting pioneers began in 1826, "when the inland barrier of mountain and desert was first passed, and from that date the influx of foreigners by overland routes becomes a topic of ever-growing importance." But no record of even tolerable completeness exists or could be expected to exist concerning it. The movement was generally directed farther north, but some of the trappers found their way into California. Those foreigners who came to stay seemed to enjoy an appreciation of their worth, and to have been liked by the people, with less prejudice against them, perhaps, than was felt against Mexicans. Citizenship, wives, and lands were easily obtained by those whose conduct was regular. "New-comers had to comply with certain formalities, and they were occassionally reminded that they were under surveillance, but no cases of oppression were recorded." The first recorded trip overland was made in 1826, by Jedediah S. Smith, who went from the Great Salt Lake by the Virgin and Colorado Rivers. Returning, he was the first to cross the Sierra Nevada, in May and June, 1827. Science is interested in two of the transient visitors of whom record is made in this period. The first was David Douglas, the famous Scotch botanist, who, after having spent five or six years in botanical researches in the North, came down from the Columbia to investigate the flora of California, arriving at Monterey in December, 1830. He had letters and influence, by the aid of which he obtained permission to prosecute his researches for six months, and, in fact, remained for twenty months. To return to British Columbia, he had to take a roundabout voyage by way of Honolulu. There was a current rumor in later years that he had found on the roots of his California plants gold enough to make a watch-seal! He perished in 1834 by falling into a pit, where he was trampled to death by a wild bull that had fallen in before him. The botanical results of his trip were published by Sir William Hooker in 1841. The other scientific visitor was Dr. Thomas Coulter, who in 1832 communicated to the London Geographical Society the results of a trip from Monterey *via* San Gabriel to the Rio Colorado and back, made in 1832. He published a map, which included the country as far north as the Bay of San Francisco and as far east as the Tule Lakes.

We have reason to anticipate a fullness of information, wholly new to the Gentile world, when the volume devoted to Utah is reached. For not only has Mr. Bancroft all the documents and all the material for the history of the Mormons which is accessible to any one else, but he is the exclusive possessor of that which is more valuable than all this, and which has never seen the light. The ruling men of the Mormon Church have given him the privilege of examining their archives, containing documents going back to the beginning of their movement. We have the Gentile story in superfluity and in unpleasant satiety; Mr. Bancroft purposes to give us the Mormon side in addition uncolored, and told as a part of the *res gesta*, and that is what the world wants to know.

The task which Mr. Bancroft undertook in the preparation of so comprehensive a work as this was one of unusual magnitude, and might well have discouraged a less earnest man. It certainly required unusual powers of application and painstaking labor to give unity and harmony to so large a plan; to reduce such a chaos of material as the history has to be built up out of to manageable shape, and to organize the work so that all should be done intelligently, consistently, and discriminatingly. But the plan is substantially executed, and one half of the work it demanded is done and in the possession of the public, while the rest of it is, we are told, in so advanced a stage of forwardness that its completion no longer depends on the prolongation of the life of the author.

The scheme contemplated the presentation in a systematized, readable, and plainly intelligible form, both in general view and in all its details and with all its changes of scene, of the history, so far as it is known or has been reported, of the tribes and states of the Pacific slope of the North American Continent from the Isthmus of Darien to Behring Strait. When we consider what these states are; what elements have entered into their composition; what vicissitudes and revolutions they have gone through during the four hundred years they have been known to white men; and how all the material is colored in all discordant hues by ignorance, partisan prejudice, or political malice prepense—it would seem almost a hopeless task to obtain comprehension even of a small part of the confused whole. Add to this, that hundreds of native tribes, having a vast geographical range and living in the most various conditions of pursuit, wealth, and civilization, had to be dealt with, and that what was to be learned about them had to be gathered and sifted from a great accumulation of printed and manuscript accounts, true and false, guessed, imaginary, and real, and from myths and traditions going back to an unknown antiquity, here obscure, and there inextricably entangled in and modifying one another—and we conceive a task calling for no slight powers of mental organization. Forty-two thousand is the number of books and manuscripts Mr. Bancroft has levied upon for his great undertaking! It took six men ten years suitably to catalogue and index thirty-five thousand of them so that they could be available for use, while the others have been gradually added. Mr. Bancroft has spent twenty-five of his best years in his work, and is spending and expects to spend other years upon it; while the pecuniary cost to him is underestimated at a million dollars.

The author has not produced, nor has he aimed to produce, a critical history nor a philosophical history, but simply to collect and preserve what existed, but was in danger of being lost. For doing that he deserves the thanks of his countrymen.

NATURAL HEIRSHIP: OR, ALL THE WORLD AKIN.

By Rev. HENRY KENDALL.

THE number of a man's ancestors doubles in every generation as his descent is traced upward. In the first generation he reckons only two ancestors, his father and mother. In the second generation the two are converted into four, since he had two grandfathers and two grandmothers. But each of these four had two parents, and thus in the third generation there are found to be eight ancestors—that is, eight great-grandparents. In the fourth generation the number of ancestors is sixteen; in the fifth, thirty-two; in the sixth, sixty-four; in the seventh, 128. In the tenth it has risen to 1,024; in the twentieth it becomes 1,048,576; in the thirtieth no fewer than 1,073,741,-834. To ascend no higher than the twenty-fourth generation we reach the sum of 16,777,216, which is a great deal more than all the inhabitants of Great Britain when that generation was in existence. For, if we reckon a generation at thirty-three years, twenty-four of such will carry us back 792 years, or to A. D. 1093, when William the Conqueror had been sleeping in his grave at Caen only six years, and his son William II, surnamed Rufus, was reigning over the land. At that time the total number of the inhabitants of England could have been little more than two millions, the amount at which it is estimated during the reign of the Conqueror. It was only one eighth of a nineteenth-century man's ancestors if the normal ratio of progression, as just shown by a simple process of arithmetic, had received no check, and if it had not been bounded by the limits of the population of the country. Since the result of the law of progression, had there been room for its expansion, would have been eight times the actual population, by so much the more is it certain that the lines of every Englishman's ancestry run up to every man and every woman in the reign of William I from the king and queen downward, who left descendants in the island, and whose progeny has not died out there.

It is a delusion to suppose that one man living seven or eight hundred years ago was one's ancestor to the exclusion of all the rest of the people living at that time in the country, and still having descendants in it. We have sprung from the whole mass ; they were all our direct ancestors ; we are vitally related to them all, directly descended from them all. Heraldry follows only one line of succession, the line of the eldest surviving son, the line that carries name and title and landed property. It is commonly imagined that one standing in this line of succession is more truly a descendant than other descendants. It is supposed that the eldest sons all the way are more truly descendants than the progeny of younger sons, or the posterity of daughters who have lost the very name. But each line of descent, whether by younger sons or by daughters, is just as real and as close as the one termed lineal agnatic. Every ancestor living 700 years ago has contributed as truly to the vitality of a present representative as the one whose name he bears, and whose peculiarly direct descendant he is considered to be.

It is morally certain, then, that all Englishmen of this generation are descendants of William the Conqueror and of Alfred the Great, and all the nobles of their times whose posterity have not died out. When we read in history of a brave deed done by an Englishman seven centuries since or more, we may say with confidence it was done by one of our fore-elders. And, when we read of one at that distant period who was a dishonor to his country, we may say with certainty he also was one of our ancestors. All the lords, princes, and sovereigns, all the wise and good, the moral and intellectual aristocracy, were our forefathers, and we are their children by direct descent. Equally all the toiling myriads, without distinction of any kind, all the beggars and vagabonds, all the villains and scoundrels, were our forefathers, whoever we may boast ourselves to be, if, indeed, they have left descendants in the land. We are of them, and their blood circulates in our veins.

If the fact of our equal descent from so many ancestors be doubted, let the matter be tested arithmetically within the circle of two or three generations. The grandmother on the mother's side was equally my ancestor with the grandfather on the father's side. She was one of four ancestors that I had in the second generation, and owns a full quarter of me. The great-grandmother on the mother's side is equally an ancestor with the great-grandfather on the father's side. She was one of eight ancestors that I had in the third generation, and claims a full eighth of me. Similarly all standing on the successive steps of genealogical descent, and whose number is seen to be doubled at every step as we rise from the lowest upward, stand on the same level, and have equal claim to ownership in those coming after them.

Some deduction has doubtless to be made from the above rule on account of the recurrence, to a certain extent, of the same lines of descent. Thus, if the father and mother are cousins, their children have only six great-grandparents instead of eight. If the grandfather on the father's side, and the grandfather on the mother's side, were brothers, their lines run up into one house, and not two separate houses, according to the common rule. Many lines must thus blend in the course of ages, and the multiplication of distinct ancestors be thus somewhat retarded. But, notwithstanding this deduction, it would require a miracle to prevent the interfusion of the blood of a whole nation within a brief period.

When we have gone back far enough for all the inhabitants of our country to have become related to us as fore-elders, they will be found, as we still travel backward, to go on for the most part intermarrying within the lines of consanguinity as drawn backward from us. The great majority of the marriages will be, of course, between men and women of the same country and the same race, who, by the operation of the law now expounded, have all been ascertained to be our ancestors. The boundaries of a country, especially in an island like ours, resemble the shores of a lake from which there is no outlet, and where the currents must circulate round and round the same basin.

Yet, as the self-contained lake does somehow manage to communicate with the great world of waters outside, as, for instance, by rain and by evaporation, so the multiplication of distinct ancestors, while retarded by nationality, is not arrested. Genealogy has curious means of planting new centers in other lands, and commencing there over again the same rapid ratio of multiplication, till successive nationalities are brought into intimate relationship. Let an ancestor be brought into the English succession from another country, and, since he can be shown to be in the course of a few generations related to all the people of that country, forthwith by his marriage here the whole nation to which he belongs is brought into our succession. One Frenchman embodies in himself, in miniature, all the French people of past times; one negro represents all the race from which he has sprung. Ancestral germs have thus been conveyed across the sea by emigration from France, from Germany, from India, and from the remotest regions to these shores, and by these means all the people of the earth will be found at no very distant period to have been brought into close kinship with us. The Norman conquest brought in all at once a large foreign element, expediting immensely our union with the people of whom they were part. The Danish invasions did the same at an earlier age; the expatriation of the Huguenots the same much later. All the world are found akin, not by going so far back as Adam, or even Noah, but within historical times.

It is often said, respecting a distant relative, "he is a thirty-second cousin." The truth is, perhaps, that he is a second or third cousin. As to thirty-second cousinship, it is startling to find that the whole human race comes within this line of consanguinity. By the ordinary unimpeded ratio at which ancestors multiply, they would amount in the thirty-second generation to 4,294,767,296; and, reckoning for all the checks to this ratio through the blending of lines of ancestry, they must be reasonably estimated at the entire population of the globe—as high, in fact, as they can possibly go. The Caffre and the Hottentot, the Japanese and the Chinese, are doubtless all of them the reader's thirty-second cousins, or nearer.

There is a tendency from many causes for ancestry to diverge and spread itself over an ever-widening area; there is a struggle of the lines to part until universality has been reached, and every human being has come into the succession. Even where a tribal or religious custom mostly confines the marriages of the men in a community to the women of the same community, there are sure to be many exceptions. Jews sometimes marry Gentiles, and set the barrier that interposed between them at defiance. Boaz married Ruth, and she brought into Judah blood mingled of all Moab. When the Quakers made it a rigorous rule that members of the society should marry only with members, gates were hung in the hedge, and the fence itself was often broken through. Proselytes were brought in from the outside; members married non-members at the cost of excommunication. The law itself had eventually to be abrogated.

The tendency to avoid kinship in marriage has helped to increase the divergence of ancestral lines. While a large proportion of the marriages consummated are between persons living in the same district, the population of the district itself is continually undergoing modification—one stream flowing in, another flowing out. No use has been made in this argument of the existence of illegitimacy, and the boundless license of many periods of our national history. Yet doubtless moral transgression has greatly widened the area of relationship, and mingled in an indistinguishable mass the offspring of the rich and poor.

Hitherto we have been looking backward at the historical multiplication of the ancestors of persons now living. If we reverse the process, and apply the law of multiplication to the future, the result is equally startling. The average number of children may be reckoned on a moderate computation at two for every household. According to this average, a man who leaves permanent posterity behind him has the number of his descendants doubled every generation. The two children are followed by four grandchildren; the four grandchildren by eight great-grandchildren. At the twenty-sixth generation the number has swelled to 67,006,624. A few more generations would render them equal to the total number of the inhabitants of the globe. So that, if one could rise from the grave at a period no further removed from us in the future than the Conquest in the past, every person he met in the land, man, woman, or child, if not a mere visitor or recent immigrant, would be one of his descendants. Every one of them would inherit something of his nature. All would be his posterity, one as direct as another. The honorable and the base, the rich and the poor, the talented and the imbecile, would alike belong to his family, now swelled to gigantic proportions through the multiplying power of time. Broadly speaking, all the inhabitants of this country about eight hundred years ago were our fathers and mothers; all the inhabitants of this country about eight hundred years hence will be our children.

The low rate of multiplication just given is often seen to be greatly exceeded. The number of grandchildren and of great grandchildren which some individuals leave behind them at death makes it easy to believe that in a few centuries an entire nation will be their veritable sons and daughters. While I have been writing this paper an old woman has died very near to my residence at the age of ninety-nine, who had thirteen children and one hundred and two grandchildren and great-grandchildren, the latter, so far as known, all living. During the same time that the paper has been in progress, a Spanish gentleman who went out many years ago to America has returned to his own country, bringing back with him no fewer than one hundred and ninety-seven actual descendants.

A single plant, if unresisted by rival plants and unchecked by such things as climate and situation, would speedily cover the whole earth. Man has really no rival, he is lord of all; he can live too in every clime, and obtain a livelihood amid tropical forests and amid eternal snows. The rapidity with which the multiplication of descendants must go forward, even according to the ordinary rate of progression, will in the course of not many generations make the whole world our children, much more if it be expedited. Successive countries will be captured by various avenues and held in perpetual possession by our posterity. The whole caldron of humanity, seething evermore with new creations, will acknowledge the presence of every individual progenitor of this period.

The race is incalculably more than the individual. The peculiarities of the individual are soon melted away in the general stream of humanity. As if his brief sway in the little circle he has filled were viewed with envy or dissatisfaction, the hand of Time begins immediately to pare down what remains of him in the earth to ever smaller dimensions until it is infinitesimal. He can insure only half of himself in any individual of the next generation, only a quarter in the generation after that, and so on. His part in the building up of any human fabric rapidly becomes insignificant. Something seems bent on working him out. As it does with his name and memorials, filling up the lettering on his tombstone with moss, destroying the writing he has left behind, wiping out all traces of him from the earth, so it does with himself and all that vitally represents his personality in the persons of his descendants. The individual is ever losing; the race is ever gaining. A man's great-great-great-grandchild, living scarcely two hundred years after him, will be only one thirty-second part of himself, and the other thirty-one parts will be due to others, that is, to the race viewed as something opposed to his individuality.

The gain in the way of extension compensates for the loss of intension. While a man's part in the individuals descending from him rapidly becomes infinitesimal, the number of individuals in whom he has part rapidly increases until it includes, as we have seen, all the nation and then all the world. This widening out of his personality corresponds to the broadening of intelligence from mere interest in local news to that which is taken in scientific generalizations, and to the tendency of moral development which is to expand the love of family into patriotism, and then to convert patriotism into philanthropy, into a regard for man as man, irrespective of language or nationality. Thus the brook seeks the river, the river the sea, the sea the vast ocean.

Each man's personality, it has to be remembered, is borrowed from those behind him. The further back in time a man's place may be, the fewer ancestors he has behind him; the greater, too, his own part in the race, viewed as a whole existent through the ages, the oftener the infinitesimal resowing of him takes place, and the greater becomes the certainty that every separate inhabitant of the earth is one of his descendants. Furthermore, when there are fewer people, the lines of ancestry blend oftener, so that in the same individual it is more probable that an ancestor will be represented many times by means of different channels of descent meeting in him after proceeding from the same source. Posterity, not very remote, will have descended from a common ancestor through several of his children. A progenitor's part who lived three thousand years ago is very much larger than that of one who lived only one hundred or three hundred years ago. He has had more to do in the shaping and molding of the whole, just as the stem has more to do in the formation of the tree than any particular branch proceeding from it. The root or the seed has a still greater part, and, if it be conceded that the human race has proceeded from one common pair, it follows that of the nature of all the individuals now living half is of the proto-father and half of the first mother. To us existing at this late date, it is interesting to note how the channels of vitality, proceeding from the original pair to us, first diverge until they reach their numerical climax, and are coincident for a considerable period with all the inhabitants of the world; then converge until they are found reduced to two again in the household from which we immediately sprang.

As the people at no very distant date in the past were all our fathers and mothers, and the people who will be living not very far distant in the future will be all our sons and daughters, so the people living at the present time are all our near relations. We may call them, with very little exaggeration, brothers and sisters. If we could be told, as we meet the passers in the streets, how near their relationship to us is, we should get a succession of surprises. We should cease to think of them as strangers and aliens, and come to feel that they were our own kith and kin. Every person would have an interest for us as a relative not far removed, and the charm of social life would be wonderfully increased.

The fact of our close kinship, as a nation, and also as a race, is calculated to stimulate philanthropy very powerfully. It is acknowledged that the nearer the relationship the greater is the claim for help, if help be needed. Even self-love comes to the aid of generosity; it is felt that what a man does for his own relations is in a measure done for himself; the disgrace of neglecting them acts as a useful spur to liberality. Advocates of slavery have vindicated their obnoxious system by maintaining the absolute inferiority of the enslaved. Caste in India has been fortified by notions of a vast and essential difference between the various orders. Oneness in nature appeals for respect and association. The oneness which is proved and emphasized by near relationship makes the strongest appeal to the interest of the mind and the sympathy of the heart. Creatures of the same kind draw together. The further a people are from us, geographically or relatively, the less ordinarily is our regard for their welfare, our concern over their calamities. The improved facilities for intercourse are destroying the effect of geographical distance; the realization of the fact that all the world are near akin will help immensely to lessen the social distance.

The close kinship of mankind especially in the same nation has an important bearing on one or two points of theology. Since mental and physical tendencies are transmissible by hereditary descent, this kinship gives to the doctrine of natural depravity an awful significance, and shows the causes of taint to our blood to be near us in time instead of being removed altogether away to the beginning of the world. If all the moral weaklings of the land who lived seven hundred years ago, all the vile and vicious, all the wild beasts in human shape, and an unknown number of such in the ages intervening, were our direct ancestors, it is not to be wondered at that unhappy propensities stir, and strive, and struggle for mastery in every man's breast. It is singular that orthodox theologians should overlook this recent pressing source of depravity to dwell on the influence upon us of an original pair living before historical times. It is equally strange that unorthodox ones should deny the existence of depravity communicated from that remote period on the ground of its supposed injustice, when it is undeniable that we are reached by ten thousand impure channels so near at hand. The question arises, How is it that the depravity fed from so many sources has not resulted before now in the complete corruption and disintegration of the race? We are able to encourage ourselves by remembering the vast amount of excellency in recent times with which we are in direct communication; the heroes, saints, and martyrs, to say nothing of the hosts of good, plain, practical people of all sorts who have left us a constitutional heritage. We have further encouragement in the law by which successive generations tend to revert to a normal type: peculiarities are got rid of, defects are supplemented, excesses are restrained; a certain amount of refuse is wrought out and cast aside age after age. The blind man has children with eyes. On the whole, we can not marvel that with such a mongrel ancestry of saints and sinners we manifest such contradictory tendencies, and are such an enigma to ourselves, as if not two men but a thousand were contending within us for the dominion in the changing moods that pass over us, and in the wild, irregular thoughts that shoot through the mind, and try to find their way to the surface to gain their own appropriate expression. That blessing and cursing should proceed from the same lips, that men should come away from prayers at church and get into very unlovely tempers at home, is doubtless very sad, but it is just what might have been expected from those who reckon among their progenitors the evil and the good, the best and the worst, of a whole country.

This doctrine of the close kinship of mankind triumphantly establishes, apart from genealogical tables, the fact that Jesus Christ had descendants from King David, but impairs the value of the fact when it is established. David, the King of Israel, flourished above a thousand years before Christ, and left behind him many children. The channels of succession being so numerous, and having their fountain-head so far back, had time before the birth of Christ to branch out in every direction, and could not have missed any genuine Jew in the land, especially if he was of the tribe of Judah. Jesus Christ, being of this tribe, was undoubtedly in the succession, and had in him the blood of the son of Jesse. But then was there a man of the tribe of Judah at least who had not? Is there a man living now who has not? Of course the conventional value of Christ's descent by what is termed lineal succession from David, and its value as a fulfillment of prophecy on that ground, are independent of the generalizing proofs which would make out all to be David's children.

The evidence seems conclusive that Mary, the mother of Jesus, had several children after the birth of her illustrious First-born. He had brethren and sisters, and if some of these left posterity in the earth, as we may reasonably suppose they did, it is certain that we are the descendants, the children, of Mary, and have a kinship with Christ, much closer physically than we have dared to believe.

In his case the phrase "Son of man" had a unique significance, but the doctrine which has been expounded in this paper shows that it has a real and solemn significance to whomsoever applied. Each of us is "son of man" in the tremendous sense that he is descended from all the people who have posterity remaining, who lived on earth a few centuries ago. Every individual living before Christ who has descendants at all has them in us. We are the offspring of the whole of humanity at that time. Every slave and every lord in the days of Julius Cæsar has contributed to our being, and, looking back to those times, each one may consider himself not the child of a thin, thread-like line of parentage, but child of the race, son of all mankind.

This subject has important bearings in the political realm. It invalidates the basis of hereditary monarchy, and shows that it rests upon a genealogical fiction. It is a depraved conventionalism, a custom born of falsehood and of wrong to single out the eldest child or any other child as the bearer of the honors and emoluments of the family to the exclusion of the rest. All the children are equally partakers of the parental nature. In the course of less than a thousand years the descendants of an illustrious sovereign get strangely dispersed, and his blood becomes mingled with the common reservoir of national life. Every marriage outside his family runs off with half of what remained of him in the succession. After being halved so often, the wearer of his name and title, the possessor of his power, needs much faith or much ignorance to believe that he is in any real sense the peculiar descendant having a claim in nature beyond millions more. If the sovereign is the descendant of William the Conqueror or of Alfred the Great, so are the subjects. On the ground of hereditary succession every man may claim to be king, and every woman to be queen.

Hereditary aristocratic titles have no foundation in nature. They are based upon deception and injustice, and at best are purely arbitary. The eldest son who takes the title is no more the child than the rest of the children. If any title is inherited it ought to be common to them all, and, if the titular inheritance continued, it would be common to all the population of the land in the course of a few ages. It is restricted to one channel of descent under the delusion that this is more direct and is somehow closer to the founder of the family than other channels. The restriction takes place by means of a wrong done to the rest in excluding them from that which is as much theirs by right of nature as his who actually enjoys it. There could be no hereditary aristocracy save by the ignorance and weakness of the community at large, who tolerate the presence of a few among them flaunting in their eyes and jingling on their ears the tokens of the general deprivation of a natural due.

The doctrine of the close kinship of the nation practically carried out would lead to a universal distribution of property. The verdict of society is that a man who has property should leave it to his children after making due provision for his wife for the remainder of her days. This is the general rule which the common judgment of mankind prescribes, leaving only a small margin for bequests outside the family circle. Entail in its present form and primogeniture are doomed to go, and only wait the hour and the man. Law has already relaxed the grasp of the eldest son on *personal* estate, and provides for its distribution. In France it compels an equal distribution of *real* estate among all the children. Taking, then, the broad rule for granted that the possessions of the parents must pass in equal portions to the children, there is seen to be wanted some strict guard on what a man bequeaths so that it shall not be squandered by his heirs. We can best follow out the result in regard to possession in land. Entail should be placed on a natural basis and carried out on a broader scale, and it would become a mighty instrument for good and for raising the general condition of the people without taking away the stimulus to labor.

There is provision in nature for the nationalization of the land. As soon as all the direct descendants are treated as heirs, the fact that these rapidly multiply till they are coextensive with the nation shows that, if the property left at death by the present possessors be similarly extended, all the land of the country now in so few hands must eventually come into the possession of the whole nation, and that not by any act of confiscation, but by simply acknowledging fact and doing justice. It would not answer, however, to go on subdividing property endlessly down to yards and inches. A limit would have to be set to subdivision and to inheritance by means of it, and after a certain generation, where the descendants had already become scores or hundreds, or after a certain degree of tenuity in the property had been reached, so that the forfeiture of his share would be no particular loss to the individual heir, it would be necessary to annex the whole to the national estate, swiftly accumulating by similar processes. If this rule were universally acted upon, though a man's descendants would cease, say, in the fourth or fifth generation to be his heirs in particular, the little amount they forfeited in this way would be more than made up to them by the many other inheritances of which they would become heirs in common with the nation. The railways could be passed through the same process by the gradual distribution of shares. As far as practicable other property should be dealt with on the same principle. This would bring about a general diffusion of wealth now congested in a few hands, and bring it about, too, gradually and safely by the operation of the great natural law of heirship through successive generations.

Already we have extensive properties that are owned by the nation at large, such as the roads and canals, the post-offices and telegraphs, the board-schools and the Established Churches, the parks, free libraries, and Government buildings. The principle is in operation, and, if it had the wider sphere that heirship demands, there would be an immense lightening of the burdens which are pressing upon the people. Each individual would commence life at an advantage, a few steps up the ladder instead of being down quite in the ditch, as are the majority —poor and penniless, dependent for everything on the exertions of the present hour. The rent of the national property might, as has been recently advocated, go to the payment of the taxes imperial and local. It might answer for the necessary work of government, for the expenses of army and navy, for the payment of interest on the national debt and its gradual liquidation, for the elementary education of the children, and for the maintenance of the aged. Though I have not read Mr. George's book, I understand that this is something like his proposal. If the yearly return of the national estate were ever found to far exceed the above requirements, it could be readily and safely disposed of by a yearly dividend, which would reverse the old tormenting order, and make the people the receivers instead of payers of taxes. It is hard to see how this moderate diffusion of property could be injurious to them. If the smaller equal inheritance would degrade them, the present holders of large estates must be in a very bad way.

That which a man has accumulated by his own exertions he has a sort of right to disperse and to squander if he choose; but that which the dead have left behind them should, as far as possible, have permanence stamped upon it, and be guarded by the state, so that it may be enjoyed by all the heirs in their turn. The savings of the present generation should enable the whole community in the next age to start from a higher level of power and comfort. The law of labor can never be abrogated, though its incidence might be very wisely extended. The inequality between the possessions of men can never be totally destroyed, but with immense advantage to the nation it might be decidedly lessened. The progress that has thus far taken place in the condition of the people has been the laying of successive strata of comforts and resources between them and the utter poverty in which their forefathers dwelt. The increase of wages, the lessening of the hours of labor, the manifold fruits of modern inventions, the accumulated treasures of knowledge which all may take without diminishing the store—such instances as these show a gradual enrichment of the people to the general advantage. Who shall say that the process has gone as far as it ought to go? What harm could ensue if the present burdens of taxation were done away, and if even every man were the recipient of a yearly income of a few pounds which no act of his could ever alienate?

The landless people of the present generation are undoubtedly proportionate heirs to all the landowners of the country living not many ages ago, if heirship be founded in nature. That all should have gone into so few hands, and the vast majority of the heirs have deen deprived, is a great and grievous wrong. Those who wish to continue the present arrangements, and would bitterly oppose their modification in the way here proposed as an injustice to the few who in future would otherwise come into possession, are willing to inflict injustice upon the many of the future who ought to come into possession.

The great possessions now enjoyed by particular individuals, and that have come down from distant times, are due to accumulated wrongs. One heir in the succession has been advantaged to the exclusion of scores, and eventually of thousands and millions. That which in nature was as much theirs as his is now his alone. That which should have flowed in many channels, shallow, but sufficient to fertilize, has been carried in a single stream, deep and full, but comparatively useless—mostly wasted. Much of the waste is seen clearly and painfully enough in the profuse and extravagant style of living, where one consumes what would decently maintain a thousand. When the properties of the country are thus piled up on a foundation of gigantic wrong, it would be unreasonable to expect a full measure of national health and prosperity, or that it should be really well with the people.—*Nineteenth Century*.

SCIENCE IN ITS USEFUL APPLICATIONS.

By Dr. WILLIAM ODLING, F. R. S.

PRESIDENTIAL ADDRESS BEFORE THE INSTITUTE OF CHEMISTRY.*

BY the attainment of our incorporation by royal charter, in lieu of the articles of association by which we have, until now, been banded together, we become for the first time an officially recognized professional body, known officially to Government, and both to municipal and to other professional bodies. Further than this, we have had formal acknowledgment made of our fitness to be charged with certain public duties and responsibilities, and have established our claim to be intrusted with correlative rights and privileges. Our profession, the public utility and importance of which have, in this way, received at length so formal a recognition, is one that we may all of us feel a just pride in belonging to. It is not, indeed, with bated breath that we need speak of ourselves as professional chemists. Chemistry, indeed, as a branch of knowledge, pertains not alone to the student, but exists also for the practitioner, and still more for the public. Of exceptional interest as a subject of study, it is of scarcely less interest from its manifold practical applications, and as a contributor to the daily wants and enjoyments of the community, a community in which all are bound up with another, and are under obligation to render services to one another. Nowadays, the ever-extending and increasingly complex wants of the community create a greater and greater demand for what are known as professional services, and for

* The original Institute of Chemistry was organized in England in 1877, under the presidency of Dr. Frankland, its second president being Sir Frederick Abel. It was reorganized in 1885, and incorporated under the title of the "Institute of Chemistry of Great Britain and Ireland." The present president is Dr. Odling, who gave his inaugural address before the new organization November 6th, and which is here given, with omission of the preliminary part, which is chiefly of local English interest.

professional services of a kind and extent that can not be rendered by the parson, or the doctor, or the lawyer; or yet by the amateur engineer, or the amateur electrician, or the amateur chemist. It is the competent services of professional men, specially trained in their several departments, that are alone adequate, and are alone accordingly in request. To the trained professional chemist, as to other professional men, interests of occasionally enormous value are committed; and some notion of the consideration in which his work is held may be gathered from the extensive resort had everywhere to his services, even by the great departments of state and by the most renowned and important of municipal and other corporations.

Among Government Departments, the War Office, the Home Office, the Board of Trade, the Local Government Board, and the Board of Inland Revenue, have each their respective permanently attached staffs of professional chemists, with whom from time to time, in relation to special subjects of inquiry, other chemists of distinction are associated. Among corporations and public institutions of all sorts, the City of London, the Metropolitan Board of Works, most of the great provincial Corporations and Local Boards, the Royal Mint, the Houses of Parliament, the Elder Brethren of the Trinity House, the Thames Conservancy, the Royal Agricultural Society, the great Gas and Water Companies, the different Metropolitan Vestries and Local Boards, and many more such bodies, have recourse alike to the regular services of their permanently attached professional chemists, and to the supplementary services of various others among us whom they find it necessary to call into consultation from time to time. And of yet greater extent as a whole is the habitual resort that is had to the services of the professional chemists by mercantile and manufacturing firms and associations, engaged in almost every variety of commerce, manufacture, and industrial enterprise. Alike, then, by the great departments of state, and by commercial firms of world-wide renown, and by traders and producers occupying a less distinguished position, the multifarious services of the chemist are ever in request. And in respect to ourselves, by whom these services are rendered, from those of us occupying the leading positions in the profession, to the most humble individuals practicing in our ranks, we are all associated in a common work, and have all a common credit to maintain, and are all under mutual obligation to co-operate with and advance the interests of one another.

It would seem, however, from observations not unfrequently hazarded by some very superior persons, whose happy mission it is to put the rest of the world to rights, that there is something derogatory to the man of science in making his science subservient in any way to the requirements of his fellows, and thereby contributory to his own means for the support of himself and of those depending upon him. Now, on this not uncommon cant of the day, a little plain speaking would seem to be very much wanted. While the investigation of nature and the interpretation of natural law are admittedly among the highest, as they are among the most delightful of human occupations, the right application of natural law to effect desirable objects is in itself a scarcely less worthy occupation; many of these objects being of paramount importance, and attainable only by the exercise of high scientific sagacity and skill, aided by a fertility of resource and a persistent elasticity of spirit, ready ever to cope with the successive novel difficulties found to be continually opposing themselves.

In this matter, as in so many others, the sense of proportion is but too often lost sight of. Because the investigations of a Newton, a Darwin, a Dalton, a Joule, and a Faraday have an importance of which few among us can adequately conceive even the measurement; because among the scientific men now or but lately living in our midst are to be found those whose investigations in pure science have not only won for them a high renown, but have earned for them the gratitude, and should have obtained for them the substantial acknowledgments of their country and the world; and because even the minor investigations and discoveries that are ever being made in pure science have all of them their merit and their value, it does not follow that the mere accomplishment, it may be in an abundant leisure, of two or three minor investigations, however creditably conducted, are to lift their authors into a scientific position, altogether above that of men whose laborious lives have been spent in rendering their great scientific attainments directly serviceable to the needs of the state and of the community. The accomplishment of such like investigations does not entitle their authors to claim exemption from the duty of earning their own livelihoods, or give them a claim to be endowed by the contributions of others with the means to jog leisurely along, without responsibilities and without anxieties, the far from thorny paths of their own predilection. However heterodox it may be thought by some, the best of all endowments for research is unquestionably that with which the searcher, relying on his own energies, succeeds in endowing himself. The work to which our natures are repugnant, not less than the work which entrances us and hardly makes itself felt as a work at all, has to be done. In some degree or other, we have most of us to obtain our own livelihood; and harsh as may seem the requirement, it will, I suppose, be conceded that the necessity put upon the mass of mankind, of having to earn their daily bread, is an arrangement of Providence which has, on the whole, worked fairly well; and further, that the various arrangements hitherto tried for exempting certain classes of men from the necessity of having to earn their daily bread, in order that they might give themselves up to the higher spiritual or intellectual life, have scarcely, to say the least of them, worked quite so satisfactorily as they were intended to. All of us are, without doubt, qualified for higher things than the mere earning of our daily bread; but the discipline of having to earn our daily bread is, in more ways than one, a very wholesome discipline for the mass of us, and even for the best of us. It may here and there press hardly on particular natures, but it is rarely an impediment to the achievement of the highest things by those having the moral qualities, the judgment, the determination, and the self-denial necessary above everything else for their achievement. Not a few of us may consider ourselves fitted for higher work than the gods provide for us, and fondly imagine what great things we should effect if we could only have our daily bread supplied to us by the exertions and endowments of other less gifted mortals. But experience is not on the whole favorable to the view that, the conditions being provided, the expectation would be realized. Experience, indeed, rather favors the notion that it is primarily the necessity for work, and association with those under a necessity to work—those in whom a professional spirit has been aroused, and by whom work is held in honor—that creates and keeps up the taste and the habit of work, whereby the vague ambition to achieve is turned to some productive account. Take, say, a thousand of the most eminent men the world has produced, and, making no allowance for the large influence of descent or training, or of association with those to whom work is a necessity, or, having been a necessity, has become a habit, consider what proportion of these men have, by their means and position in early life, been free from any stimulus or obligation to exert and cultivate their powers; and consider, on the other hand, what proportion of them have been stimulated to exertion and success by the stern necessity of having either to achieve their own careers, or to drop into insignificance, if not indeed into actual or comparative degradation and poverty. We ought, indeed, all of us to be students, and to be above all things students; but the most of us can not be, nor is it desirable, save in the case of a special few, that we should be only students. We have all our duties to fulfill in this world, and it is not the least of these duties to render ourselves independent of support from others, and able ourselves to afford support to those depending upon us. Fortunate are we in being able to find our means of support in the demand that exists for the applications of a science which has for its cultivators so great a charm. To judge, however, not indeed by their coyness when exposed to the occasional temptation of professional work, but rather by their observations on the career of others, the most sought after and highest in professional repute, the pursuit of professional chemistry is, in the opinion of some among us, a vocation open to the gravest of censure. It is praiseworthy, indeed, for the man of science to contribute to his means of livelihood by the dreary work of conducting examinations in elementary science for all sorts of examining-boards, and by teaching elementary science at schools and colleges, and by giving popular expositions of science at public institutions, and by exchanging a minor professorial appointment, affording abundant opportunities for original work, in favor of a more lucrative and exacting appointment involving duties which, if rightly fulfilled, must seriously curtail these same opportunities. It is praiseworthy of him to add to his means by compiling manuals of elementary science, and by writing attractive works on science for the delectation of general readers; but it is forsooth derogatory to him, if not indeed a downright prostitution of his science, that he should contribute to his means of livelihood by making his knowledge subservient to the wants of departments, corporations, and individuals, alike of great and small distinction, standing seriously in need of the special scientific services that he is able to render them.

A glance back suffices to show how foreign to the ideas of the great men who preceded us is this modern notion of any reprehensibility attaching to applied or professional science. In his earlier days, Professor Faraday was largely employed in connection with all sorts of practical questions, and until almost the close of his life continued to act as scientific adviser to the Trinity House. No man was more constantly occupied in advising with regard to manufacturing and metallurgic and fiscal questions than Professor Graham, who ended his days holding the official position of Master of the Mint; a position in which he succeeded another eminent man of science, less known, however, as a chemist than as an astronomer, Sir John Herschel. As in these typical instances, so also in very many others; and, if I may be allowed to draw at all on my own personal experiences, I would say that some of the most pleasant remembrances of my past life relate to the occasions on which I had the good fortune, early in my career, to be brought into association, as a junior professional colleague, with some among the then most eminent of scientific men. It did not indeed happen to me to be associated in this particular manner with Faraday, or Graham, or Daniel, or yet with their frequent colleague, Richard Phillips, one of the early Presidents of the Chemical Society, for many years the able and omniscient editor of the "Philosophical Magazine," and the leading professional chemist of his day. But among those who have passed away from us altogether, or have for some cause or another quitted our ranks, my recollection goes back to professional association with a host of distinguished men of science, whose membership would, of itself, suffice to insure an honorable estimation for any profession to which they belonged. On different occasions it has been my lot to be engaged in advising on various questions in conjunction with Arthur Aikin, a personal friend of Priestley, writer of a still valuable dictionary of chemistry, the first Treasurer of the Chemical Society, and for many years the leading authority in regard to chemical metallurgy; with Dr. Thomas Anderson, of Glasgow, an assiduous and successful worker in the then unfamiliar field of organic chemistry, and for many years consulting chemist to the Highland

Society; with Professor Brande, the pupil and successor of Davy, at the Royal Institution, long time one of the Secretaries of the Royal Society, an early President of the Chemical Society, and, in his professional capacity, Director of the Die Department at the Royal Mint; with Sir Robert Christison, of Edinburgh, one of the most scientific of British toxicologists and pharmacologists, an original worker in many fields of inquiry, President of the Royal Society of Edinburgh, and a selected, though not an actual, President of the British Association; with Dr. Warren de la Rue, the friend of us all, more than once President of the Chemical Society, and a Vice-President, Medalist, and Bakerian Lecturer of the Royal Society; with Dr. Hofmann, the first Professor at the College of Chemistry, and Assayer for many years to the Mint, one who can claim so many of us as his pupils, and who, as a professional chemist, no less than as an investigator and teacher, ever set an example of energy and vivacity to all his associates, working on one occasion the long night through in order to extract from paraffine-oil a specimen of benzene, ready for exhibition in court on the following morning, an instance of professional devotion which, as the presence of my immediate predecessor, Sir Frederick Abel, reminds me, is not wholly without a parallel. Proceeding in my enumeration, I may mention Sir Robert Kane, then of Cork, a teacher and worker of originality and wide erudition, to whom chemists are indebted for their now familiar conception of amidogen; also Dr. Allen Miller, Professor at King's College, London, and Assayer to the Mint, a President of the Chemical Society, and for many years Treasurer of the Royal Society; also Sir Lyon Playfair, then Professor of Chemistry at the University of Edinburgh, now a member of her Majesty's Privy Council and President of the British Association, one to whom we are indebted for his hearty sympathy with the objects of the Institute, and for the unsparing exercise of his efforts and influence on our behalf; also my relative by marriage, Alfred Smee, a pioneer in electro-metallurgy, and inventor of the galvanic battery by which for the third of a century the greater part of the galvano-plastic work of this country has been effected; and lastly, Robert Warington, chemist for many years to the Society of Apothecaries, the founder and first Secretary of the Chemical Society, and a frequent contributor thereto of his characteristically ingenious observations. And not only with the above-named eminent men of science, but with many others also, has it been my fortune to be professionally associated, including, I regretfully have to add among those who have passed away from us, some of the most distinguished original members and warmest friends of the Institute, as Dr. Stenhouse, Sir William Siemens, Professor Way, Dr. Angus Smith, Dr. Voelcker, and Mr. Walter Weldon. Moreover, among the leading men of science of the present day, Sir Frederick Abel, Mr. Crookes, Professor Dewar, Professor Frankland, Mr. Vernon Harcourt, Dr. Tyndall, and Dr. Williamson, are either the holders of definite professional appointments or are otherwise more or less actively engaged in the work of the professional chemist. A profession surely stands in need of no apology which includes and has included in its ranks, within such a limited period, such a host of distinguished members.

So far, moreover, from his professional eminence and usefulness being made a matter of reproach to the scientific man, it should constitute rightly a claim to his higher consideration; and, far from being accounted a disparagement, should be held as an addition to his scientific standing. In the professions most allied to our own on the one side and on the other, this is well recognized. The physician and the engineer are not merely students of pathology and of mechanics, however important may have been their contributions to pathology and mechanics respectively, but they are the distinguished craftsmen in their respective arts. And, whether or not they may have made important contributions to pure science, their rank as eminent scientific men is everywhere and rightly conceded to them. A lucky chance happening to any professional man may indeed bring him to the front, but no succession of lucky chances can ever happen that will of themselves prove adequate to keeping him there. Great qualities are ever necessary to sustain great professional positions; and to be for years one of the foremost in a scientific profession is of itself at least as substantial an evidence of scientific attainment as is the publication of a memoir on some minute point, say of anatomy, or chemistry, or hydrodynamics, for example. And it is so recognized, and very properly recognized, even in quarters where pure science admittedly reigns supreme. Leading engineers and leading physicians and surgeons are every year admitted into the Royal Society, not on account of the importance attaching to any special contributions they may have made to mechanical or pathological science, but mainly because of their eminence in their several professions, in which to be eminent is of itself an evidence of scientific character and of extensive scientific knowledge. It may indeed be taken as beyond question that, to obtain and retain a leading position in a scientific profession needs, among other things, the possession of high scientific attainments. I say among other things, for without moral qualities in a notable degree, sympathy, endurance, courage, judgment, and good faith, no such professional success is conceivable. Professional eminence is the expression necessarily of scientific ability, but not of scientific ability alone. The self-engrossing science of the student has to be humanized by its association with the cares and wants, and the disappointments and successes, of an outside world.—*Chemical News.*

THE PHYSIOLOGY OF THE FEET.

By T. S. ELLIS, M.R.C.S.

DISREGARDING the action of those parts not affecting the feet, the act of walking may, as I think, be thus described: The foot put forward should reach the ground when nearly flat; the toes, the organs of feeling, should be the first to reach it, not the heel, which could not be without some concussion, however slight. The heads of the metatarsal bones and the toes are then pressed firmly against the surface. The great-toe, having only two phalanges, is held down in its whole length, the flexor tendon being attached to the final phalanx close to the joint between them. The little toes touch at their tips only; their flexor tendons being also attached to the final phalanx of each, traction on them causes a rising at the joint between the two proximal phalanges as the tips of the toes are drawn backward. By this arrangement, in the one case a firm, solid base is formed from which the body can be propelled onward; in the other an additional hold on the surface, by a rudimentary action or grasping, is afforded. As the body is moved onward, the extensors of the great and of the little toes, without lifting them from the ground, where they are held by the flexors, draw the leg forward, while the anterior tibial, in assisting this movement, serves another purpose. It is attached to the crown of the arch, and in action tends to prevent any sinking there as the weight of the body comes upon that structure. This purpose is much more effectually served in another way: the muscles of the calf allow the heel with firmness and precision, but withal gently, to touch the ground, and the step is completed.

The heel is then raised, but the weight of the body is not borne, as commonly stated, by the muscles acting on the heel and by them only: the deeper muscles, the posterior tibial with the long flexors and the long peroneal, acting round the inner and outer side of the ankle respectively, all of them assist in raising the body and at the same time have a most important influence in maintaining the arch. The tibialis posticus, attached by its expanded tendon to the tarsus on the under surface beyond the astragalus, the bone on which the weight of the body rests, materially assists in supporting the arch from below. The long flexors passing beneath the arch from one abutment to the other are, in relation to it, as bowstrings to a bow, or rather, as the two tendons cross each other, they may better be compared to the tie-rods of a roof.

This arrangement of the two tendons crossing each other is very curious: that going to the great-toe is lowest in passing round the ankle, in order to be, as nearly as possible, at the extremity of the arch or bow at that end, as it is at the opposite one; if, however, it passed directly across the sole from end to end there would be little if any free space beneath, but, being crossed by the flexor longus digitorum, which comes round the ankle at a higher level, it is so drawn up that a hollow beneath the arch is formed; the flexor accessorius, by drawing back the tendon of the flexor longus pollicis, compels it to cross the other nearer to the heel, and so increases this effect. Thus the flexor longus pollicis, regarded as the chord of the arc, becomes itself an arc.

The tendency to inversion which all these muscles, acting from the inner side of the ankle, might occasion is corrected by the long peroneal on the outer side; it also, acting on the base of the first metatarsal bone, a point considerably beyond the center of gravity, has a bracing action on the arch, as the weight of the body falls upon it. In this, too, no doubt the small muscles of the sole assist those of the calf, but I can not accept the converse statement that it is the "muscles of the sole assisted by the tibial muscles" which "are the active agents." The deep muscles of the calf have much the more potent influence. Thus it is that by the action of muscles the whole of the strain which the weight of the body in walking would otherwise throw on the ligaments binding the arch together is removed, and any tendency to flattening of it prevented.

This, which has been called my "bowstring theory," is the view I put forward in a little monograph, "On the Arch of the Foot," written and printed in 1877. For reasons therein given I could not accept the view that the arch is maintained by ligaments, or believe in the carriage-spring movement of those ligaments, yielding to the weight of the body, as the explanation of a springy gait. It is really due to the heel being gently lowered and firmly raised. Upon this the grace of walking depends. On the same grounds I hold that in proper walking the foot does not lengthen. Camper, whose treatise is regarded as classical, but which, as I think, contains many important errors of fact and of induction, said that his knowledge of anatomy taught him that it did so. On the contrary, I believe that as the tightening of a bowstring approximates the ends of the bow, so the bowstring action of the flexor muscles on the arch of the foot tends to shorten it. If walking were a succession of standings, flat-footed alternately on either foot, no doubt there would be lengthening, as the ligaments of the arch yielded. Such a mode of progression is, we know, possible; and, indeed, we sometimes see something like it, hardly, however, to be called walking. I would ask those who believe that the foot in walking lengthens "one tenth of its length, or about an inch" (a statement on high authority made during the past year), to consider this: What, then, would be the condition of the sole, after a long walk, from friction caused by the necessary sliding with the weight of a man borne upon it? As in every mile of the ordinary march of soldiers more than a thousand steps are taken on each foot, the result would not be pleasant even to imagine.

The position of the foot is important. To turn out the toes seems to me to be not only untrue to nature, but objectionable as well as inelegant. Camper regarded it as incontestably the proper position. For the following reasons I believe that the toes should be directed forward, the inner margins of the feet parallel: It is desirable that the propulsion of the body onward from, and consequent thrust backward on, the foot, and especially on the great-toe, should be in the direction of its length rather than obliquely across it, not only as giving a firmer bearing from which to propel the body onward, but as diminishing the friction on the sole and consequent tendency to foot-sore. This applies also to the smaller toes in a less degree. The long axes of all the toes continued backward seem to converge on the heel. By standing with the bare foot and springing forward it can readily be seen how much more tendency there is to slide on the sole when the foot is turned out than when it is directed forward. In the latter position, too, the arch is much more firmly braced up—a fact recognized by surgeons who advise, in cases of flat-foot, that the toes should be directed inward rather than outward. In standing, the everted position is not more stable. When a body stands on four points I know of no reason why it should stand more firmly if those points be unequally disposed. The tendency to fall forward would seem to be even increased by widening the distance between the points in front, and it is in this direction that falls most commonly occur.

Those who look on the human foot as fully partaking of the beauty of which artists in every age have regarded the human body to be the highest expression, ought not readily to admit that the boot which best conforms to its outline, reveals its features, and expresses its leading characteristics, will require an apology for want of elegance. I, at any rate, can not admit anything of the kind. The human foot is, moreover, an object of far more than the ordinary interest belonging to every part of the human structure. In the monograph already mentioned I ventured to suggest that, anatomically, there is no more marked distinction between man and the lower animals than is to be found in the special development of the foot.

However much we may regard it as in itself calling for admiration on account of its fitness for the purposes it has to fulfill and for others it may on occasion serve, the human foot is far more remarkable as an adaptation of the mammalian type, modified to suit a purpose kindred to but differing from that which the corresponding member supplies in other animals. The heel has its special form and significance in that man only has one adapted for crushing an offensive object beneath it. The large size and important function of the great-toe is also a specially human feature. In the mammalian typical limbs the bones of the hand and foot (or rather, to avoid confusion, in four-handed or four-footed animals, *manus* and *pes*) are arranged on a uniform plan: to each five digits, the first having two phalanges and the others three. The first digit is generally attenuated, often suppressed, but whenever it exists it has two phalanges only.

This curious difference is nowhere, so far as I know, explained. I can not discover that any animal (below man), recent or fossil, exists or has existed from the times of the Trias formations till now in which this arrangement has appeared to be essential. It may be of some advantage in the quadrumana, and doubtless the human hand is thus better fitted for its functions, but it seems to me to be much more difficult to imagine it possible for any other arrangement to exist in the foot unless the whole scheme of it, so to speak, were changed. It is essential that the only joint in the great-toe should be drawn to the ground by the strong flexor tendon attached to the final phalanx close to it; if another joint existed it must rise up, as occurs in the other toes, and the solid bearing would be lost. Apart from this, it must be admitted that it is mainly due to the special development of the great-toe in a line with the long axis of the foot that man is enabled to exercise the attribute, in all ages regarded as a noble one, of standing erect. Yet this special feature is the one which the conventional boot does most to conceal, and in direct proportion as it is successfully concealed the wearer is supposed to be dressed in good taste. It would seem to be regarded as necessary to reduce the foot to even-sided symmetry; but there is no law of beauty which requires this. Mr. Ruskin assuredly would not say that it is in any of "the eternal canons of loveliness" decreed that an object to be beautiful must be symmetrical. An architect required to provide more space on one than on the other side of a building would not seek to conceal or even to minimize the difference; he would seek rather to accentuate it, and give the two sides of the structure distinctive features. To me it appears that it is on this principle only that a boot, to be at once useful, graceful, and appropriate, can be designed.

Moreover, the sense of symmetry, natural and reasonable where the same function has to be performed, is, or ought to be, satisfied by the exact correspondence of the two feet, which, taken jointly, may be described as the two halves of an unequally expanded dome, irregularly extended at the base, the greatest extension being in the line of the greatest expansion of the dome, through which line the division runs. The dividing-line thus makes the margin of the two feet parallel to each other. It may be that the inner margin of the great-toe, if produced backward, would fall a little distance from the inner side of the heel. A perfect adult foot, in which the great-toe is not and never has been diverted outward, and in which there has been no consequent thickening of the large joint, is not easy to find. In children the inner line is often visibly concave. It may be remarked that in rest the great-toe is everted as well as drawn upward, in which position the toes are usually packed in a tight, medium-pointed boot; it is only therefore in action as the toes are pressed against the ground that the full extent of the approximation to a straight inner line is seen.

In the boot it is of first importance that the sole (technically, the part in front of the hollow or "waist") should allow the great-toe to occupy its natural position; it must, therefore, be straight, or nearly so, on the inner margin; but it is of little use to provide the room thus given unless it be occupied; the foot must be invited to occupy it by giving plenty of room in the upper leather on this side. It is obvious that where a flexible material is fixed on both sides and left loose between, it can be drawn farthest from the surface to which it is attached, in a line midway between the fixed parts. For this reason the highest part of the foot, which is on the inner side, will, in any case, have some tendency to go to the middle line of the boot where most room can be made; this tendency is largely and needlessly aggravated by the high ridge of the last being along the middle line instead of being on the inner margin. But not only ought the room there given to be much more according as the foot projects the more upward; it ought to be proportionally more. I have insisted that the foot does not lengthen in walking, but rather shortens. This shortening, due to the powerful action of the long flexors, causes the foot to rise across the middle, the rising being almost entirely on the inner side. Here, therefore, over (not by the side of) the ball of the great-toe is special room required. The lateral thrust, too, already spoken of as consequent on turning out the toes, tends much to displace the foot and to throw it against the outside of the boot. Toe-caps also are objectionable, as giving the most room in the middle line and inviting the great-toe to occupy that position.

No useful or ornamental purpose is served by leaving space unoccupied round the outer margin of the sole opposite the little toes, as if it were necessary to make the two sides of the boot to match. No angle existing in nature, none should be represented; the outline of the sole of the boot should conform to that of the foot.

If it be true, as already stated, that grace in walking, as well as free propulsion of the body onward, and maintenance of the arch in walking, are all due to the free action of the flexor muscles, letting the heel down with gentleness and precision, and raising it with firmness and vigor, it follows that none of these can be if the boot prevent the heel from going down, a necessary antecedent to springing up. A low heel, therefore, if any, is imperative. The perfect boot should have none. Nor can the free action of the flexor muscles have full effect, so as to draw the toes to the ground, if the sole be turned up at the toes, especially if it be a stiff one. Some turning up will come from walking, however good, but there is no reason why it should be aggravated by having the boot-last so. In it the sole should be flat to the end.

Objection is made that boots with a straight, or nearly straight, inside line give the feet a pigeon-toed or inverted appearance, which is unnatural. This is not altogether due to the eye being accustomed to a more conventional pattern. It is, I am sure, mainly due to a removable cause. Any conspicuous line, that of the laces or a seam, is always carried from the front of the leg to a central point on the upper surface of the foot. The eye, falling on this line, in imagination continues or produces it, and so divides the front part diagonally into two very unequal portions, the larger on the inner side. I have found that if the line of the laces or seam be kept parallel throughout to the line of the long extensor tendon—in other words, along the crest of the ridge, thus marking out a distinctive feature—the unpleasant effect is removed.

In proper walking, which can not be done in an improper boot, friction of the foot on the sole and of the latter on the ground is reduced to a minimum, the sole being pressed against, not rubbed along, the surface. This is shown by the very little wearing of the leather; when at last it does give way, it should be at an oval spot a little distance from the margin of the sole, under the middle joint of the great-toe. This is the last point to leave the ground in walking; here, therefore, is the greatest tendency to slide on the surface and consequent friction.

The great-toe, in any but the most perfect feet now to be found, is so easily diverted outward that socks and stockings with a straight inner line are very desirable; indeed, no others can be said to really fit the feet. When any considerable distortion exists, a separate stall for the great-toe is necessary.

For the reasons given, a last should have the inner margin nearly in a line with the inner side of the heel, and joining in front by a rounded angle a long curve on the outer margin, where no angle should be shown. The sole should be flat, touching the base-line in front. The thickest part (highest vertically) should throughout be on the inner margin, especially above the ball of the great-toe. The boots should have low heels—to be perfect, none. The line of laces or of any conspicuous seam down the front should be in a line corresponding with the inner margin of the foot along the highest part. The boot should, if possible, be left on the last for a considerable time, to overcome the tendency of the leather to recoil after the forcible stretching to which it has been subjected, and so to fix it in its proper shape.—*Lancet.*

SKETCH OF FRANK BUCKLAND.

FRANCIS TREVELYAN BUCKLAND, who was almost universally known as Frank Buckland, was the eldest son of Canon William Buckland, of Christ Church Cathedral, Oxford, afterward Dean of Westminster, and author of the "Buckland Bridgewater Treatise," and was born in Oxford, December 17, 1826. He attended school at Cotterstock, in Northamptonshire, and spent two years with his uncle, the Rev. John Buckland, at Laleham School, near Chertsey; attended Winchester College, where Dr. Moberley, afterward Bishop of Salisbury, was head-master, from 1839 to 1844; and in the latter year entered Christ Church College, Oxford, where he took his bachelor's degree in 1848. He then entered upon the study of surgery at St. George's Hospital; passed the College of Surgeons in 1851; and became house-surgeon at that institution in May, 1852. In 1854 he was gazetted assistant-surgeon to the Second Life-Guards. In 1860 he applied for promotion to a full surgeoncy; but a rule was adopted, different from the old tradition of the Guards, that medical officers should be promoted as vacancies occurred in the same regiment, by which promotion was made to go by seniority in the brigade or at the discretion of the colonel; and the preference was given to an assistant-surgeon of older standing from another regiment. Disappointed by this action, and encouraged by the growing success of his literary and scientific career, Buckland resigned his commission in 1863, and devoted himself with ardor to what was to be his life-work in natural history and literature. "Fish-culture was henceforward his chief pursuit, and his life became one of incessant activity, bodily and mental"; but every fact connected with nature was interesting to him, and was held worthy to be communicated to others. He had begun to write in 1852, for periodicals, those articles which were afterward published collectively in his "Curiosities of Natural History." In 1866 a third series of this work was published, and Buckland, associated with some friends, started the periodical "Land and Water," of which he was the inspiring genius till the time of his death. In 1867 he was appointed one of the two Inspectors of Fisheries for England and Wales, succeeding Mr. Frederick Eden, one of the inspectors originally appointed under the Salmon-Fisheries Act of 1861. This position he held and worked in for the remainder of his life He shunned no exposure in the execution of his favorite pursuits, but rather courted it, and professed to enjoy getting wet, whether by being rained upon, or by wading up to his neck in water while searching for eggs. Too many of these exposures, and carelessness in indulging in them, brought on the illness which proved fatal to him. He died, of disease which had begun with an inflammation of the lungs nearly two years before, on the 19th of December, 1880.

Such is a skeleton chronology of a life than which none more active, varied, and useful, is recorded in scientific biography. For the story of the lives of many men of science we have to be satisfied with a skeleton almost as meager as this; but happily that is not the case with Frank Buckland. He has, in the papers constituting his "Curiosities," and in "Land and Water," so revealed himself in his inner life, with his thoughts, feelings, and purposes, and his friends and the brother-in-law who has prepared his biography have given such vivid descriptions of him as they saw him, that the man is made to stand out before us almost as in his very life and personality.

From these sources we learn that, when weighed shortly after his birth, the infant Frank was found to be heavier than the leg of mutton provided for the family dinner of that day; and that a birch-tree was planted in honor of his arrival, the taste of the twigs of which he learned to know well. His early years, as described in his mother's journal, reflected in miniature his character in maturer life. For facts, especially of natural history, he had from childhood a most tenacious memory. At four years of age he began collecting specimens, and at seven he commenced a journal. Earlier than this, at two and a half years of age, "he would have gone through all the natural history books in the Radcliffe Library without making an error in miscalling a parrot, a duck, a kingfisher, an owl, or a vulture." When he was four years old a clergyman brought to Dr. Buckland, from a considerable distance, some "very curious fossils." They were shown to the child, who, not yet able to speak plainly, said, "They are the vertebræ of an ichthyosaurus." At three years of age his mother could get him to learn nothing by rote. His mind was always at work on what he saw, and he was very impatient of doing that which was not manifest to his senses, yet he was not considered premature. He excelled in apparently strong reasoning powers, and a most tenacious memory as to facts. He was always asking questions, and never forgot the answers he received, if they were such as he could comprehend. And he was always wanting to see everything done, or to know how it was done; and was never happy unless he could see the relation between cause and effect.

It was not surprising, as Buckland's biographer remarks, that his love of nature should grow with his growth, for it was inherited from both parents, and was encouraged by every association of his youth. "In his early home at Christ Church, besides the stuffed creatures which shared the hall with the rocking-horse, there were cages full of snakes, and of green frogs, in the dining-room, where the sideboard groaned under successive layers of fossils, and the candles stood on ichthyosauri's vertebræ. Guinea-pigs were often running over the table. In the stable-yard and large wood-house were the fox, rabbits, Guinea-pigs, and ferrets, hawks, and owls, the magpie, and the jackdaw, besides dogs, cats, and poultry, and in the garden were the tortoise (on whose back the children would stand to try its strength), and toads immured in various pots, to test the truth of their supposed life in rock-cells." Then there were the visits to the museum, and the afternoon drives, with which the hunt for some natural object was usually associated.

At Winchester, he was known as "a boy utterly indifferent to personal appearance, but good-tempered and eccentric, with a small museum in his sleeve or cupboard," an expert hand in skinning badgers, rats, etc., "and also setting wires at Blue Gate, for cats." A school-fellow who slept in the next bed to him used to observe him "to get up in the middle of the night, and designedly in half-darkness carefully bind two fagot sticks together, for the purpose, as he said, of accustoming himself to be called up as a surgeon, half asleep, to do some professional duty under adverse circumstances." So we may follow him during his four years at this school, extracting the poison-fangs from adders, dissecting cats, and even successfully attempting the eye of the warden's dead mastiff. With his good-humor and spirits and his uniform amiability and obligingness, he became the most popular boy in the school. "Fond of school-work he was not, but he did his duty fairly, got through his 'construes' somehow, and ground the regulation grist of dreary Greek and Latin verse. Neither did he care for games." Toward the end of his school-days his anatomical studies enlarged their scope, and he undertook fragments of humanity, which he obtained secretly from the hospital and secretly dissected.

Of his life at Oxford, Dr. Liddon observes that there hung an odor of physical science about his rooms, "which increased as you got nearer. If you passed through the outer room into the study, you found the occupant surrounded by friends and playmates, irrational or human, and deep in scientific investigation after his own fashion, which, be it observed, was as industrious as it was irregular." His fellows did not then appreciate the reality or value of the work he was engaged in, "or that he was in fact educating himself much better than most of us were doing." Here we find a friend visiting him at his rooms having to tuck up his legs on the sofa to keep the jackal, which is prowling about the room, from biting them, while the jackal feasts himself upon the Guinea-pigs under the sofa; and we are introduced to Tiglath-pileser, or Tig, the pet bear, who attracted the notice of the British Association in 1846 as a guest in cap and gown at the garden-party, where he was introduced to Sir Charles Lyell, Prince Canino, Milne-Edwards, and Sir T. Acland, and was mesmerized by Lord Houghton.

Buckland's first article was published in 1852, after the author had attempted an unsuccessful paper on the muscles of the arm. Mr. White Cooper, the Queen's oculist, called at the deanery, and was invited down-stairs to see the pet rats. Frank took them out of the cage one by one, and described in a most interesting way the habits and peculiarities of each. Mr. Cooper then suggested to him to put down on paper all that he had related, for publication. Frank demurred, because he did not think he could write anything worth reading, but finally produced the article, which was published in "Bentley's Miscellany." This was the beginning of the series which were afterward collected and published as "Curiosities of Natural History."

He gave his first lecture in December, 1853. It was delivered at a working-men's coffee-house and institute, and was on the human body, or "The House we live in." Of his qualities as a lecturer we are told that "he inherited from his father the faculty of investing a subject, dry in other hands, with a vivid and picturesque interest, and to this he added a variety of subject and a fund of droll yet apt illustration peculiarly his own. 'I can't get on,' he used to say, 'until I make them laugh; then we are all right.' His drollery was irresistible, yet was always informing; while his vehement earnestness, and alternation of the serious with the humorous, never failed to arrest attention."

Two or three years after entering the Life-Guards, it occurred to Buckland that he was "getting too much in the natural history line," and must give more attention to medical subjects. He did not, however, but went deeper and deeper, and with more and more interest, into natural history; and his life in this period was full of his observations and experiments and collecting, and the writing of those charming articles for the periodicals. He began to write regularly for the "Field" newspaper in 1856, and continued to do so till 1865, or shortly before he started "Land and Water." He prepared a new edition of his father's "Bridgewater Treatise," receiving valuable aid in the work from Professor Owen and Professor Quekett, the former of whom looked upon it as "the best elementary book that a country gentleman or azure lady could take up" for the sciences of geology and paleontology. It was framed, says Mr. Bompas, Buckland's biographer, "on such broad lines as to be of permanent value, notwithstanding the time which has passed since it was written, and the rapid expansion of geological science."

The year 1859 was distinguished for Buckland by the search which he prosecuted in person for fourteen days, in the vaults of St. Martin's-in-the-Fields, for the body of John Hunter, the father of modern physiology, which he found at last on the 22d of February. He took his friends down to see it, including Professor Owen, who expressed himself much pleased. "I wish I could have made a sketch of him," he writes, "with his hand on the coffin, looking thoughtfully at it; it would have made an excellent subject." The coffin was afterward re-interred in Westminster Abbey. In the same year, the idea, carried out somewhat later, of forming the Acclimatization Society, was suggested to him after eating a dinner of eland or African antelope.

Immediately after leaving the Life-Guards he threw all his energy into the promotion of fish-culture; and his diary is full of the records of his experiments in hatching, of consultation, and of the giving of instructions to others who had become interested in the enterprise. He showed his apparatus and explained it at the exhibitions. He lectured at the Royal Institution on the subject, and gave the grave members of that body the novel experience of laughing at the racy humor with which the new science was explained, "while the earnestness with which the national importance of the subject was enforced was none the less impressive." The substance of this lecture was afterward expanded into a book on "Fish-hatching." He was invited up into Ireland to see what was the matter with some salmon-fisheries in Galway. Seeing a very fine salmon-ladder, he climbed down into it and imagined himself a salmon, congratulating himself on narrow escapes from the nets and crevices below, and thinking how very desirable it would be to get up to his autumn quarters in Lough Corrib. To preserve and make popularly visible the results of his investigations into fish-breeding, he made the series of casts of the roe of fish and of the forms of fish at different stages of growth, which is exhibited at the South Kensington Museum. He next studied oyster-culture, and gave lectures, scientific and popular, on that. These occupations prepared the way for his appointment as Fish Commissioner, and rendered it the most appropriate one that the Government could make.

In studying the problem of fish-passes for salmon, to which he gave a great deal of attention, he made it a principle to enter, so far as was possible to man, into the feelings of a salmon, as he did at the Galway ladder ; and so thoroughly did he carry out the principle that he became "as an inspector almost amphibious, wading the pools below the weirs, and feeling the force and direction of the current. . . . No wonder, then, when it was publicly stated that, in his evidence before the House of Commons, he had leaned rather to the interest of the millers than of the salmon-fisheries, he protested that his statements had either been misconstrued or not understood. 'Having placed myself as a shield over the salmon interests, I have, as is the fate of shields, received most of the arrows.'" With regard to the cultivation of the English rivers, he saw that the conflicting interests could be reconciled without injury to any ; and he strove unceasingly, and with no little success, to propagate the belief among all classes that they were each and all interested in the preservation of salmon. He continually lifted up his voice against the pollution of rivers, and told the people of Gloucester that the Chinese, who use everything in the way of manure, call the English barbarians because they pour their sewage into the rivers. The beginning of the illness from which Mr. Buckland died dates from January, 1879, when he was attacked with inflammation of the lungs after having been engaged in packing eggs from Australia in the ice-house of the steamship Durham. He was again attacked in November of the same year, after exposure in a violent snow-storm following the last inquiry it was his privilege to hold, among the fishermen at Cromer. His last fishery report was presented in March, 1880. It was a document which he endeavored to make as far as possible an outline and guide to those who wish to open up and improve salmon-fisheries, in whatever part of the world they may be situated. He went for the last time to the fishery-office in August, 1880, and left his house for the last time, on the 21st of the same month, to visit a newly arrived orang-outang. He continued to write, however, for "Land and Water," and completed a new edition of the "Natural History of British Fishes," and a revised edition of White's "Natural History of Selborne" in the last month of his life. He also arranged and revised a series of articles, which was published after his death, as "Notes and Jottings from Animal Life."

Buckland's journals occasionally show glimpses of those thoughts and feelings that men do not usually talk much about to others; the passages strikingly exhibit his simple-hearted earnestness. Thus, in 1865, he says: "I can not help thinking that the Almighty God has given me great powers, both of thought and of expressing those thoughts. Thanks to him, but I must cultivate my mind by diligent study, careful reflection in private, and quick apprehension of facts out-of-doors, combined with quick appreciation of ideas of others; in fact, strive to become a master-mind, and thus able to influence others of weaker minds, whose shortcomings I must forgive. . . . Why should I not imitate the example of that great and illustrious man to whom I owe so much of my education (William of Wykeham, founder of the Winchester School), and endeavor to do as much good as possible in my humble way? I will therefore begin next week, and put up a storm barometer for the use of the fishermen at Herne Bay." And, December 16, 1866, "Thanks be to God, I have preserved a straight course to the best of my abilities, and, though I see others taking short cuts, I think honest dealing and true is the safest ballast to keep the ship in trim, through the sea of difficulties and dangers." Just after his forty-third birthday, he wrote, "I do not aspire to do more than my duty in that station to which it has pleased God to call me, but I want to do it nobly and well."

There was another, a curiosity side to Frank Buckland's character. Nothing was without interest to him; and he was hardly less fond of studying the curiosities of the Barnum Museums than the objects of natural history with which he spent most of his life. He very much enjoyed the bearded woman, of whom he wrote quite extensively, was on good social terms with Captain Bates the giant, and Miss Swan the giantess, and Mademoiselle Millie-Christine, the "two headed nightingale"; knew nearly all the fat women and the other giants, and was fond of making up parties for these people, with the Chinamen, Aztecs, Esquimaux, Zooloos, Siamese twins, tattooed New-Zealanders, and whatever queer specimens of mankind happened to be on exhibition at the time, as fellow-guests.

CORRESPONDENCE.

THE UNIFORMITY OF NATURE AGAIN.

Messrs. Editors:

I READ the first few pages of the Bishop of Carlisle's essay on the "Uniformity of Nature," in the last number of this magazine, with a lively expectation that some of the fog and uncertainty left hanging around the question by the debaters of the "Metaphysical Society" was to be cleared up. But all such expectation ended before I had finished the article. The fog and uncertainty became more bewildering than ever. In fact, it seems to me the worthy bishop missed the mark entirely. He set out to tell us what was meant by the uniformity of Nature, and arrived at the conclusion that, outside of celestial mechanics, it, in effect, meant simply unchangeableness of the weather, uniformity in the direction of the wind, invariableness in the form and density of bodies, etc., and was therefore a principle of only a very limited application.

How absurd, in the first place, to go back to ciphering out by Newton and Laplace of the problems of the laws and motions of the heavenly bodies, for the origin of the practically universal belief in the uniformity of Nature! You might as well go back to them for the origin of our practical belief in density, gravity, inertia, or in the existence of the sun and moon themselves. The whole course of our lives is predicated upon our faith in the uniformity of Nature, upon the belief that fire burns, that cold freezes, that gravity is always operative. Would a man ever plant seed in the ground if he did not believe the laws which govern its growth and development were constant? Have the laws (no matter how ignorant we are of them) which govern steam, which govern all fluids and solids and gases, which govern contraction and expansion and condensation, ever been known to fail? The moment any uncertainty is discovered here, our whole philosophy of mechanics is in ruins. Because the weather is changeable, does the bishop therefore think that the laws which govern the formation of clouds, which determine the course of the winds, and the precipitation of moisture in the shape of rain and snow, are not uniform; that, given the same conditions, the same results will not follow? Would he pray for rain, or for the rain to cease? Would he pray for the postponement of an eclipse? Or would he say that, because man has changed the face of the earth, he has not done it under the rigid operation of natural law? that he has reversed the law of gravity, the laws of heat and cold, of wet and dry, of the tides and the seasons? Is it not true, rather, that he has done it by strictly following and obeying these laws? A belief in the uniformity of Nature does not mean a belief in the uniformity of appearances or of phenomena. The law is not disproved because some of the worlds are large and some small, some hot and some cold, some dense and some thin; or because some animals have two legs and some four or six, some feathers and some hair, or because some crows are white and some swans black, or because some fruit has the seed upon the outside and some on the inside. But show us a country where the trees are walking about, and the men are rooted to the ground, and our belief in the uniformity of Nature will at least receive a severe shock. Would not the same conditions that produce a white crow or a white negro once always produce a white crow or a white negro? This, then, is what we mean and must mean by the uniformity of Nature, that, *given the same conditions, the same results will always follow.* If this truth does not hold good at all times and in all places, then, indeed, is "the pillared firmament based upon rottenness." A breach in the uniformity of Nature means a breach of this law. If ice should fail to melt in the fire, or if water should flow up-hill, or lead swim where a feather would sink, then would the uniformity of Nature be disproved. If the Bishop of Carlisle, or any other person, will make an axe-head swim upon water, as Elisha did, and under the same conditions that would send the iron to the bottom at all other times, then must we either give up the belief in the uniformity of Nature, or else believe in the existence of a set of laws which may be brought to bear upon material bodies by the human will, so as to reverse or annul the laws by which they are ordinarily governed. And the existence of such laws and of such power of the human will is an assumption which no sane man can accept.

If the sun should fail to rise to-morrow, it would be no breach of the uniformity of Nature. If the sun failed to rise, could it be from other than physical or natural cause; from the operation of laws which are uniform in their workings? If we are to believe what astronomers tell us about the disappearance of certain stars, then the sun of some world or worlds has failed to rise on the morrow. Have given the same conditions, and would not our sun disappear also? No; facts of this kind can not be relied upon to invalidate the principle of the uniformity of Nature. But if the sun stood still for a moment, and no ill-results befell the earth or its inhabitants, that would indeed invalidate the principle.

Pressure and cold will liquefy air, perhaps solidify it, if enough could be brought to bear, but solidified air would not be a miracle, *unless performed without physical means*, like the water and wine miracle in the New Testament; but if the air should fail to support combustion in any given case, under conditions in which it ordinarily supports it, that would be a miracle, and would disprove the uniformity of Nature. It is true that our belief in the uniformity of Nature does not rest upon the same basis as our belief in the principles of mathematics; for instance, that two parallel lines can never meet if indefinitely extended, or that the three angles of a triangle are equal to two right angles, but for my own part my belief in one is just as unshakable as my belief in the other. I do not know, from experience, that no particle of matter can be destroyed, and yet I believe it absolutely. We do not, any of us, know from experience that any calamity would befall the earth if the sun were to stand still for half an hour, yet does anybody doubt it?

I notice that all the divines who have spoken or written upon this subject withhold their belief in the principle of uniformity, in order to save that other cherished belief—the belief in the Biblical miracles. It is incredible what ducking and dodging they will be guilty of, what metaphysical fogs they will conjure up, and what enormous assumptions they will swallow, in order to keep their childish fables from being discredited. The Bishop of Carlisle says the scientific man "can well afford to be generous" and leave the theologians in undisturbed possession of their venerable old scarecrows; but science knows no generosity but the generosity of truth. A miracle is the suspension or annulment of natural law, and there is not the slightest proof, physical or metaphysical, that a natural law ever has been, or ever can be, suspended or annulled except by some other well-known natural law, which thus comes into play and keeps up the continuity of Nature; and the belief or assumption that there has been or can be is the worst kind of infidelity—infidelity toward the works of One in whom there is no variableness or shadow of turning.

JOHN BURROUGHS.

WEST PARK, NEW YORK, *November* 23, 1885.

SCIENTIFIC FREEDOM.

Messrs. Editors:

I NOTICE, in your issue for November last, an editorial comment upon the attitude which Mr. St. George Mivart has assumed, in his recent article in the "Nineteenth Century," on "Modern Catholics and Scientific Freedom." Permit me to correct what seems to me an erroneous inference on your part in regard to this matter, to wit, that Mr. Mivart's opinion is Catholic opinion. So far from this being the case, Catholic opinion holds that Mr. Mivart, in the expression of such views as he puts forth in his late article, is treading upon rash and dangerous ground, and that the *animus* of his paper is without doubt heretical. Catholics can not safely follow him into the extremes to which he goes, nor is it to be supposed that Mr. Mivart's individual opinion is either an authentic or authoritative expression of Catholic views as regards Galileo or evolution, although it must be admitted that the utterances of a gentleman of Mr. Mivart's justly earned scientific and philosophical reputation merit the most respectful attention and careful consideration. While it can not be said that Mr. Mivart's paper contains any formal heresy, its tone is certainly doubtful and inconsistent with the spirit of the Church. He bases it upon a presumed mistake on the part of the Church in the so-called condemnation of Galileo. Mr. Mivart calmly takes this as a matter of course, and does not pretend to advance a single argument in favor of his position—an easy way, indeed, of "brushing aside" the objections of all opponents. In the eyes of Catholics and all impartial witnesses, the Church has never made any such mistake as Mr. Mivart strangely and surely, without due consideration of the facts of the case, imputes to her.

In the first place, a condemnation to be *de fide* must come *ex cathedra* from the Pope himself, and be promulgated in brief or bull *as such*. Secondly, the condemnation of no congregation alone is binding *de fide*; and, thirdly, there was not even such condemnation of the heliocentric system by the Congregation of the Index. Facts are facts, and the slip-shod assumption that a thing is such and such can not pass unchallenged, especially when an argument or theory is based upon a misrepresentation. A congregational condemnation requires a unanimous vote by the members of the Congregation, and in the case of Galileo only seven out of ten cardinals signed the paper condemning his doctrine. Furthermore, the heliocentric system was not a proved fact in Galileo's time, but merely a scientific probability with tremendous weight of scientific authority against it, and, in the then crude condition of physical knowledge, the action of the seven cardinals in condemning the new theory can be readily defended upon grounds of prudence.

In conclusion, I would like to call your attention to a flagrant fallacy in Mr. Mivart's paper—a blunder, indeed, which it seems strange that a man of his logical acumen should make: In answering a possible objection, namely, that the question in hand is not within the province of the supreme ecclesiastical authority's defining power—"that is, outside the *depositum fidei*"—he says: "What is or is not within the supreme authority's province to decide must be known to that authority. An infallible authority must know the limits of its revealed message. If authority can make a mistake in determining its own limits, it may make a mistake in a matter of faith." Now, the gist of the first half of Mr. Mivart's paper is taken up by the extended assumption that ecclesiastical authority did make a mistake in determining its own limits in the case of Galileo. Therefore it must logically follow, according to Mr. Mivart's proposition, that (supreme?) ecclesiastical authority may make a mistake in a matter of faith. Again he says: "Men of science may have a truer perception of what Scripture must be held (since it is inspired) to teach than may be granted to ecclesiastical authorities"; that "God has taught us (in the instance of Galileo) that it is not to ecclesiastical congregations, but to men of science, that he has committed the elucidation of scientific questions, whether such questions are or are not treated of by Holy Scripture, etc."; that "it must be admitted that men of science so succeeded, and that ecclesiastical authority so failed, in interpreting the true and inspired meaning of God's written word." It is the duty of men of science, therefore, to point out the limits of infallible authority, is Mr. Mivart's assertion. Certainly this is a contradiction to his former proposition, that "an infallible authority must know the limits of its revealed message." Moreover, in the concluding portion of his article, Mr. Mivart coolly tells us up to what limits ecclesiastical authority infallibly extends, and weighs it in the balance against scientific probability with an implied inference in favor of the latter. Mr. Mivart never learned such logic from Catholic sources. He poses in the exact attitude of the objector he so cogently answered in the beginning. Therefore does his own reply rebound upon himself—an infallible authority must certainly determine its own limits.

While respecting Mr. Mivart's attainments to the utmost, Catholics can not do such violence to their faith and their reason as to follow him upon the rash ground whither, no doubt, some hasty and inconsiderate motive has hurried him.

Yours respectfully,
CONDÉ B. PALLEN.

ST. LOUIS, *October* 27, 1885.

THE GENESIS OF A TORNADO.

Messrs Editors:

AT Orange Heights, in Central Florida, on Sunday, October 11th, a stiff breeze was blowing from the north, as it had blown for some forty-eight hours previously. Masses of clouds, with which the air was laden, were scudding by like ships under full sail. Several times during the day I had noted that an upper current was bearing the higher clouds in an exactly opposite direction. During the afternoon the upper current gradually settled down, until it squarely opposed its adversary, presenting the singular spectacle of two cloud-laden currents of air rushing rapidly together from opposite directions. My point of observation being on an eminence, commanding an extensive view of the surrounding country, I had a fine opportunity to watch the progress of events. For perhaps half an hour these two air-currents flowed swiftly together without apparent result; but presently there appeared in the west, scarcely a mile distant, and just where the two currents came together, a heavy mass of clouds, which constantly increased in density and blackness. The south wind grew constantly more persistent, and although its antagonist showed no signs of weakening, it was gradually crowded out of its course toward the west, and for a quarter of an hour the direction of the two currents was squarely at right angles. Then the great cloud-nucleus, which had so far remained stationary, began slowly to rotate, the east wind passing across the north side, and thence around toward the south; the south wind passing up the east side, and thence around toward the west.

As soon as the rotary motion was established, a progressive motion began. In a few minutes the whole mass had moved out of sight in a northerly direction, and the south wind had full sway. When it was reported next day that buildings and their occupants had been injured by a "cyclone," a few miles to the northward, I was perhaps the only person to whom the news was not unexpected. Fortunately, the aërial monster made its first descent in the pinewoods before attaining great velocity, and was torn and dissipated by the forest before it could rebound.

It seems unfortunate that the terms "tornado" and "cyclone," whose primary meanings afford no clew by which they may be distinguished, are popularly used in exactly the opposite sense from that in which the Signal Service and scientific writers use them.

CHARLES B. PALMER.

ORANGE HEIGHTS, FLORIDA, *October* 13, 1885.

EDITOR'S TABLE.

THE DECLINE OF THE GHOST.

A LONDON correspondent of the "Boston Herald" makes the significant and, from our point of view, encouraging statement that, in all the Christmas annuals—and their name is legion—published this season, there is hardly to be found a single ghost-story. Formerly ghost-stories were of all the most attractive; and somehow they were thought to be particularly suited to Christmas-time. Nowadays the ghost is left out in the cold. In this festive season no one invites him in to so much as "warm his toes," to quote the expression of a prominent Democratic politician. Why is this? What has made the change?

The change is due to several causes. If asked to name the most general of these, we should say *the growing* intelligence of the age. If people don't care to talk or read about ghosts as they once did, it is because they no longer believe or even half believe in them. The world of the living is encroaching more and more upon the world of the dead. In very primitive times men not only believed in ghosts with all their heart and soul, but they attributed to them the same range of activities for good and evil as they attributed to living men. The powers of living men in those days were so limited that it was not paying the ghosts a very inordinate compliment to suppose that they could do as much. But steadily, as the powers of living man increased, as he acquired a more extended control over Nature, the prestige of the ghost, who became more and more conspicuously unable to imitate him, diminished. To-day we leave the ghost out of our reckonings entirely; we neither ask his aid nor strive to avert his malice. When a man is once duly certified as dead, we do not look for any continuance of his personal activity, however great the influence of his character may still be in the world.

The ghost, we fear, has also suffered in popular esteem through being investigated. Modern philosophers have not been afraid of the investigation; they have pushed the ghost hard from age to age, from race to race, from country to country; and their verdict is that, while the ghost-idea has been very potent in the world in past times, and still flourishes in the dark places of the earth, the ghost himself has no estate or effects that it would be worth anybody's while to try to levy upon. The return to the warrant is the disappointing one, *nulla bona*. The ghost, in all his alleged travels through the centuries, has left no monument. There is not one solid piece of work anywhere extant that can be credited to a ghostly origin. If he ever "materialized," he was careful to "dematerialize" again before any one could get a sample of his beautiful work. But, although the ghost himself does not stand out as a *vera causa* of anything, the belief in ghosts has affected in the most important manner the whole course of civilization. This fact the philosophers have brought very prominently forward, and in doing so they have presented for examination such an infinite and grotesque variety of ghost-beliefs, and of usages and ceremonies connected therewith, that the very name of ghost, instead of awakening, as formerly, a host of superstitious terrors, is, to-day, far more suggestive of some methodical and not over-exciting treatise on primitive man. In short, the ghost nowadays is more apt to make us yawn than to make us shudder. What wonder, then, that he no longer rules as of yore in Christmas literature, and that his general usefulness for purposes of sensation is about at an end?

We shall, perhaps, be confronted with the present wide-spread belief in spiritualism. Is not the ghost active, it will be asked, in spiritualistic circles? Well, spiritualism itself has, in our opinion, been an agency for discrediting the ghost, or, at least, for narrowing and regulating his heretofore willful activities. The spiritualistic ghost, in a word, has been tamed by the medium. He no longer goes gliding or skulking about upon his terrifying nocturnal errands; on the contrary, he comes meekly at the call of his master or mistress, and, the conditions being favorable, utters through the table-leg such harmless platitudes as seem most suited to the average intelligence of the audience. This is a great improvement upon the old plan, according to which every man met his ghost in solitude at the midnight hour, and, with his blood in a state of distressing coagulation, was compelled to listen to some dire prediction of coming doom. All our methods nowadays are more or less scientific, and the comfortable *séance* may be compared to the beneficent lightning-rod, with its many points for draining off the otherwise dangerous electrical accumulations of the atmosphere. Instead of meeting the ghost alone, and encountering the full weight of his supernatural terrors, we meet him in pleasant company, where his force is so dispersed that no one gets more than a proper, moderate, and enjoyable share. At the same time, the ghost that comes and goes at the medium's call, and talks reasonably and mildly through the table-leg, is not, *quâ ghost*, the equal of his more independent and less calculable predecessor. The ghost has declined, there can be no question about it.

Well, as we hinted at the outset, we part with the ghost without reluctance. We think good Christmas-stories can be written without drawing on senseless and half-affected terrors for their interest. We think that literature in general will be the better for shaking itself free from the baseless delusions of by-gone times of ignorance and savagery. The ghost has done nothing in the world that gives him any claim upon our respect or remembrance. He was necessary in his day, in the sense that men had no choice but to believe in him; but, now that we have risen to a point of view that renders him totally unnecessary either for theoretical or for practical purposes, we shall do well to lay him finally to rest. We want to concentrate our energies on this world, to develop all that is best in human life, to methodize our knowledge, to strengthen our hold upon all sound moral principles. For these purposes, close study of facts is required. We need to see things as they are, and to refer them to human welfare, taken in its broadest and highest sense, as a central point. As long as the ghost survived, he could override, and too often did override, our practical judgments; and men never felt sure as to how far they could trust the plain dictates of common sense. But, with the decay and disappearance of the ghost, common sense, purified by the scientific method, assumes full control of human life and reigns without a rival. Henceforth we become free and responsible men—free to follow the dictates of reason, and responsible for doing so. We can now give to the rising generation an integral education founded on reason, and can bring home to their minds as never before the salutary conviction that the reign of law is universal and unbroken—that not even a ghost can violate it—in short, that ghosts and all things of which independence of natural law is predicated are mere figments of the untrained imagination. This, we say, is henceforth possible. It remains to make the possible actual, and to impress upon education once for all that character which no sensible man can doubt it is destined to take in the not distant future.

LITERARY NOTICES.

Ecclesiastical Institutions. Being Part VI of the "Principles of Sociology." By Herbert Spencer. Pp. 193. Price, $1.25.

The great life-work of Herbert Spencer, the "Philosophy of Evolution," advances toward completion, but it has moved slowly of late. Persistent ill-health and occupation with other subjects, and other parts of the system than that immediately in hand, have considerably delayed the appearance of the present volume.

Of the general nature of Spencer's "Synthetic Philosophy" little needs here to be said. Our readers are aware that it is a systematic attempt to explain the course of nature, the progress of life, the origin of man, and the institutions of human society, by one universal law of unfolding known as evolution. While in one aspect this system is simply a new organization of knowledge based upon the progress of science, and more comprehensive and unified than anything previously attained, in another aspect it is a new body of doctrine which discredits and replaces the most wide-spread and deeply cherished traditional beliefs of mankind. In the volume now before us Mr. Spencer has reached that stage in the development of his system in which he comes into the sharpest collision with all-prevalent religious dogma.

No discussion of the evolution of human society is possible which does not make the study of primitive social conditions and ideas prominent and fundamental. If the higher social forms were potentially involved in the lower, and had grown out of them by the working of natural laws, then the first and most important step of the investigation must be into the nature, capacities, and limitations of the primitive man, and the character of the primitive elements of society which grew out of, and were determined by, the attributes of the primitive man. Accordingly, the first part of the first volume of the "Principles of Sociology"—"The Data of Sociology"—is devoted to primitive man and that order of primary conceptions which was embodied in the earliest and rudest social institutions. These institutions are now so highly developed that we have got in a way of separating ourselves from "the heathen" by a great gulf, which makes all continuity of relations between the lowest and the highest impossible. But, if evolution be true, the highest is derived from the lowest by unbroken chains of causation, and there is no other possible way of explaining and understanding existing institutions than by tracing their derivation back to primitive germinal conditions. This is, at any rate, the only way open to science which is an exposition of the natural order; and sociology only becomes a true science as it is pursued by the method adopted by Mr. Spencer of working out the laws under which social progress has taken place. The data of sociology in the primitive conditions which initiated the lowest social state constitute, therefore, the essential basis of the science, and determine the whole course of subsequent elucidation.

In Part II Mr. Spencer works out "The Inductions of Sociology," or the nature, structure, and functions of the organism of society; and in Part III, "The Domestic Relations," he treats of the maintenance of species, the relations of the sexes in primitive society, and the development of the family.

Volume II of the "Principles of Sociology" begins with Part IV, on "Ceremonial Institutions," the evolution of which is traced from early to advanced societies. Part V takes up "Political Institutions," and these with their devolopment by the same method. "Ecclesiastical Institutions" (Part VI), now published, as the title imports, treats of the evolution of existing religious organizations from their lower forms in primitive society. Its necessary implication, of course, is, that the religious, like all other social institutions, have a natural genesis, and can only be explained as derivations from pre-existing forms which carry us backward and downward to the religious notions, rites, and observances of the earliest men. The nature of the religious idea is first unfolded, and it is shown how religious ceremonies were at first mixed with others, so that medicine-man, ruler, and priest, were combined in the same individual. The rise of a separate priesthood and of religious hierarchies is then traced out, and the argument is pursued till we reach the modern forms of ecclesiastical institutions, "Church and State," "Nonconformity," and "The Moral Influences of Priesthoods." Two other parts remain to be written for the completion of the second volume of "The Principles of Sociology," viz., "Professional Institutions" and "Industrial Institutions"; but there is reason to expect that these will be completed with less delay than has occurred with Part VI. We find a notice of the present volume in the "Pall Mall Gazette," which is so excellent that we make an extract from it:

"Ecclesiastical Institutions" begins with a short restatement and re-enforcement of the ghost-theory of the origin of religion already laid down in the first volume of the Sociology. It is interesting to note how much new confirmatory evidence has been rapidly accumulated during the intervening period; and Mr. Spencer therefore wisely chooses most of the fresh instances by which he strengthens his case from works published since the appearance of his earlier volume. In one of these in particular, the Rev. Duff Macdonald's "Africana," conclusions almost identical with Mr. Spencer's own have actually been arrived at by a Scotch missionary in the heart of Africa, in apparent total ignorance and independence, and without a passing glimpse of their ulterior implications. From the origin of the religious idea itself, here assigned to the belief in a soul, and consequent ancestor-worship, Mr. Spencer gradually passes on to the evolution of ecclesiastical or hierarchical systems. Beginning with the medicine-man, as the propitiator or averter of hostile ghosts, and the priest properly so called, as the propitiator and attendant of friendly ghosts—the family gods or manes—he proceeds to trace the gradual development of the organization which results with increasing culture from the last of these two classes of functionary. Descendants, he shows, are the first priests; and more especially male descendants, at least wherever the position of women has become one of marked inferiority. But the eldest male descendant in particular—in short, the head of the family—tends to concentrate upon himself the highest duty of the priesthood. Moreover, as the chief gods in early communities are deceased rulers, the king, as their living representative, exercises the functions of priest also. In process of time, the king frequently finds the priestly offices clash with other duties, and then he delegates them to others: they are performed by proxy. Hence in most instances the origin of a distinct non-royal priesthood. The rise of such priesthoods is well shown in the case of the Flamens, instituted at Rome to replace the king during his temporary absence. As the ghost gradually develops into the god, polytheistic priesthoods of the advanced type are evolved side by side with the evolving religion. Sometimes the Pantheon has its relative ranks assigned by conquest and incorporation; the gods of the vanquished tribes take their place amicably in the same system with the gods of the victors, but naturally enough on a lower level. Eventually the slow elevation of one great god to a position of marked superiority in the Pantheon may give rise to a gravitation toward monotheism. Thus, to the philosophic Greeks of the age of Socrates, Zeus had almost arrived at that point of supremacy over other gods which lifts the "father of gods and men" into the true monotheistic position, the other deities at the same time sinking to the subordinate grades in a sort of angelic hierarchy. Mr. Spencer next goes on to notice the value of the ecclesiastical system as a social bond, especially in early times, the military and civil functions of priests, and the question of the relations between Church and State. A very Spencerian chapter on Nonconformity is replete with its author's ingrained independence and individuality of character; for Mr. Spencer is nothing if not individualist in fiber. The book ends with an ecclesiastical and then a religious retrospect and prospect where timid waverers may find much to console and to reassure them. Mr. Spencer does not see in the threatened changes of form any final menace even to religious worship in its proper essence. He anticipates that there will always remain a necessity for qualifying the too prosaic and material form of daily life by religious observances; that a sphere will still exist for those who are able to impress their hearers with a due sense of the mystery which enshrouds the universe; and that musical expression to the sentiment accompanying this sense will not only survive but will undergo further development. Finally he concludes with the reiteration of the idea already so fully insisted upon in the "First Principles": 'One truth must ever grow clearer—the truth that there is an inscrutable existence everywhere manifested, to which [man] can neither find nor conceive either beginning or end. Amid the mysteries which become the more mysterious the more they are thought about, there will remain the one absolute certainty, that he is ever in presence of an Infinite and Eternal Energy from which all things proceed.'

INTERNATIONAL SCIENTIFIC SERIES, NO. LI.

Physical Expression: Its Modes and Principles. By Francis Warner, M. D., Lond., F. R. C. P. New York: D. Appleton & Co. Pp. 372. Price, $1.75.

This is an old subject much discussed by artists, anatomists, alienists, and physiognomists, from Leonardo da Vinci onward. It has a copious literature, and, in the long list of works given by Dr. Warner in his bibliography, those of Sir Charles Bell, on the "Anatomy and Physiology of Expression," and of Charles Darwin, on the "Expression of Emotion in Man and the Lower Animals," are prominent. But so interesting a subject as that of the physiological signs of inward states could not fail to attract multitudes of observers who have contributed to it in many aspects. Fancy and speculation, however, have outstripped science with its explanations of the double mechanism involved. There has been great recent advance in our knowledge of the structure and functions of the nervous system, and in the development of psychology, from the physiological side; while results from both are of great value in arriving at the principles involved in expression. Dr. Warner takes up the subject broadly and aims to treat it in the light of all that has been gained in the various lines of research that bear upon it. Premising that the work is written with clearness and judgment, and is fully illustrated, the reader will gain the best idea of its contents by a statement of the topics considered. The first five chapters are devoted to an analysis of the nature and the modes of expression. Chapter VI treats of its physiology; Chapter VII of its pathology; Chapter VIII of postures; Chapter IX of expression in the hand; Chapter X, expression in the head; Chapter XI, expression in the human face; Chapter XII, expression in the eyes; Chapter XIV, the infant and adult; Chapter XVII, art criticism; and Chapter XIX, new apparatus for observing and recording expression.

Recent American Socialism. By Richard T. Ely. Baltimore: N. Murray. Pp. 74.

The author passes the history of the early socialistic movements in the United States with a rapid sketch-review, and gives his attention principally to the consideration of socialism as it has manifested itself since the publication of Mr. George's "Progress and Poverty." His object is to present the character of the movements, not to pass judgment on them; and it is no compliment to the intelligence of average readers that he has felt it incumbent to excuse himself for not obtruding his own views of their merits and demerits; as if, in recording that some of the organizations advocated dynamiting, he should think it necessary to say explicitly that he thought that very bad. In his presentation, the author has endeavored to let the parties concerned speak for themselves as far as possible, thereby securing further accuracy and impartiality. He classifies the advanced Socialists of the present day into the two groups of the Internationalists—a party of violence, believing in the use of dynamite and like weapons of warfare as a means of attaining their purpose—and the Socialistic Labor party, who condemn these tactics, and some of whom have not renounced all hope of a peaceable revolution of society; and calls attention to the superior character of the men of the latter party as compared with those of the former. Besides these are the labor unions, not actually and avowedly socialistic, but liable to tendencies in that direction and claimed as at least prospective allies by the socialists. The danger from these movements is real, though the extreme peril may not be immediate; and "of course we all hope for the best, but in the mean time it may be safer to fear what is worse, and it can do no harm to be watchful." As for a remedy, "there is no simple, easily applied formula which will cure social evils, and any one is a quack who pretends to have found one. Repressive legislation, in the absence of overt acts, has failed to repress the growth of the socialistic sentiment, and is likely to fail. The cure is to be sought in the opposite direction, of finding out what are the real, reasonable grievances of the men among whom this sentiment is cultivated, and devising and applying measures to ameliorate them. Then, with this purpose kept honestly in view, "in the harmonious action of state, church, and individual, moving in the light of true science, will be found an escape from present and future social dangers. Herein is pointed out the path of safe progress; other there is none."

Planting Trees in School-Grounds, and the Celebration of Arbor-Day. Washington: Government Printing-Office. Pp. 64.

This is a document issued by the Bureau of Education for the purpose of cultivating interest in the planting of trees and of turning attention in the direction in which the work may be most profitably done. It contains "lessons from history" and other facts, to show the importance of preserving the forests; selections from literature and poetry, to be used in making up the programme for the exercises of Arbor-day; and a practical essay on "Planting Trees in School-Grounds." In this paper we observe the suggestion that, in selecting the kinds of trees to be planted in school-grounds, regard should be had to their liability to injury from accident, their tendency to sprout where not wanted, the agreeable or disagreeable odors that they may emit, the ornamental character of their flowers or fruit, their longevity, rate of growth, and other circumstances tending to make them more or less acceptable in the places where they are to remain. The American elm and the soft maples appear to be among the trees best adapted to this purpose.

Offices of Electricity in the Earth, pp. 42; and Origin of Species, pp. 76. By H. B. Philbrook. New York: "Problems of Nature," 21 Park Row.

These two pamphlets, which together attempt a new cosmology and a theory of development intended to take the place of the "mistaken attempt" of Darwin, furnish an example of the nonsense which a class of visionary theorists imagine they can pass off for science. The basis of Mr. Philbrook's system is that the universe and all its parts and contents are manifestations of electricity. When he comes to details, he is startling as well as amusing. Thus: "The atmosphere is only a continuation of the condensation of the electricity of the solar system, and each atom of gas of this abundant element is but a slightly condensed globe of mica." Gold "is produced simply by a great pressure of particles of mica. Silver is constructed by the pressure of chalk; copper by the pressing of the mica partly decomposed, and the substance is but little different from gold. Iron is produced by pressing quartz and the undecomposed mica in it." Coal is formed by the exposure of coral to great heat, and exists wherever there are mountains: in the Orange Mountains of New Jersey, and in Massachusetts, "sufficient coal for a whole nation," and if bored for deep enough, will be found there. Less heat than is required to convert coral into coal produces trap.

Niagara Park Illustrated. Edited by Alice Hyneman Rhine. New York: Niagara Publishing Company. Pp. 112. Price, 50 cents.

The author gives as a reason for having prepared this book, "a desire to commemorate the freedom of Niagara from individual possession, and becoming in a manner the property of the world. Surely, if anything deserves a printed formal recognition, it is the removal of that great indignity done to Nature's masterpiece in the past." Her thought was a happy one, and her execution is worthy of it—and as nearly worthy as a modest human effort can presume to be, of the subject. A better guide the visitor need not ask for, and a more agreeable companion in a guide he is not likely to get. The directory of points of interest on the American and Canadian sides forms a but relatively small part of the book, but it is the practical part, and is ample for its purpose. The mass of the book is made up of choice articles from travelers and poets, most of them classics in English and American literature, describing the falls or reflecting the emotions which they have awakened; in short, it is a compendium of that which is best in the literature and romance of the falls. These articles are accompanied by numerous excellent illustrations.

History and Management of Land Grants for Education in the Northwest Territory. By George W. Knight. New York: G. P. Putman's Sons. Pp. 175. Price, 50 cents.

This work is number three in the series of papers of the American Historical Association. It reviews the history of all the grants of land that have been made by Congress in aid of education in the Northwest Territory and the States of Ohio, Indiana, Illinois, Michigan, and Wisconsin; the dispositions that were made of them in the several States; the manner in which the funds accruing from them have been managed; and the net results in benefit to education that have been derived from them. The grants were variously made to the Territory as a whole, and to the States in severalty; they included the "school-section" in every township of thirty-six sections; saline lands, swamp-lands, grants for seminaries or universities, grants for agricultural colleges, and special grants. The grants have in no case been as well managed as they might have been, and have been in some instances badly managed, with much waste; but, with all this, they have been "instrumental, in a degree that can not be estimated in mere dollars and cents, in promoting the cause of education. It is doubtful if with the wisest management the school-land could have been made to maintain unassisted the work for which it was set aside. Perhaps the greatest benefit rendered by the funds has been in fostering among the people a desire for good schools. Without the land grants, the burden of maintaining free schools would have seemed oppressive to the new State, but, aided by the income of the funds, the people have grown into a habit of taxing themselves heavily for the support of education. Thus the funds have made practicable a system of education which without them it would have been impossible to establish."

City School Systems in the United States. By John D. Philbrick. Washington, D. C.: Government Printing-Office. Pp. 207.

This work is No. 1 of the "Circulars of Information" of the Bureau of Education for 1885. Its author is one of the most experienced of American city school superintendents, and one who has written or said a great deal on educational subjects; and in it he has presented an extensive review of the principles and conditions of the educational organizations, generally, of all the towns in our country having populations of more than eight thousand or thereabout, and particularly of the larger cities which have the most clearly defined systems. The points to which attention is chiefly directed cover the administration and organization of the schools; the classes and kinds of schools; the studies, supervision, programmes, and supplementary reading provided for; industrial education; physical and other drill; gratuitous instruction; gratuitous text-books the tenure of office of teachers; the sex of teachers; examinations, promotions, and exhibitions; the question of "recess and no recess," concerning which he speaks with force against the abolition of recess; school ages; sufficiency of accommodation; school-houses, museums, decorations and art; pedagogical libraries; and coercive attendance.

The Boys' and Girls' Pliny. Edited, with an Introduction, by John S. White, LL. D. New York: G. P. Putnam's Sons. Pp. 326, with Illustrations. Price, $3.

In this adaptation, which is the third and last of a brief series of classical authors — Plutarch, Herodotus, and Pliny— which the editor has prepared for the reading of boys and girls, the selection is made from the most interesting parts of Pliny's "Natural History." As the author's science, however pleasant reading it may be—and in that respect it is not excelled—would not be good science in the present day, it calls for frequent correction; this is given in all cases where Pliny's statements have been proved erroneous, except where they are so evidently preposterous as to need no comment. For his foot-notes, the editor has had recourse to Cuvier, Bostock, and Ajasson, devoted students of Pliny, he says, "whose work can rarely be improved upon." In the introduction are given the life of Pliny and his nephew's account of his death by the eruption of Vesuvius.

Twenty-five Years with the Insane. By Daniel Putnam. Detroit: John Macfarlane. Pp. 157. Price, 75 cents.

The author of this book was for twenty-five years Chaplain of the Michigan Asylum for the Insane, at Kalamazoo, and he sets forth here the results of his experience and observations in that capacity. After an historical review of the development of the modern methods of taking care of the insane, he considers their proper care in asylums, their treatment outside of asylums, depicts the opinions and feelings of patients, and discusses the relations of schools, religion, alcohol, tobacco, and other narcotics, inherited tendencies, and crime, with insanity He believes that asylums and hospitals for the insane have done much for the relief of one of the most pitiable forms of human suffering, and that it is possible for them to do more and better in the future.

The Co-operative Commonwealth in its Outlines. By Lawrence Gronlund. Boston: Lee & Shepard. New York: Charles T. Dillingham. Pp. 278. Price, $1.

This book presents to the reader, in a concise, logical, and readable form, the principal propositions of modern socialism, from the point of view of a socialist. It has been written, according to the professions of the author, that it may be seen that the social and political phenomena in all progressive countries, and particularly in our own country and Great Britain, are, in a perfectly natural manner, evolving a new social order, a social-democratic order, to which the name of the "Co-operative Commonwealth" is given, or, that socialism is no importation, but a home product, wherever found; to give good reasons for expecting that the new social order will be a "happy issue" to every one, and to justify the conviction that the situation must come to this new order within a comparatively short period, or to barbarism. The author has also a more serious purpose than the one of mere information, which is to prepare the public to take such an attitude as to make the revolution, which he foresees as a certainty, a bloodless and dangerless one, resulting in the establishment of a wholesome security.

The Blood-Covenant. By H. Clay Trumbull, D. D. New York: Charles Scribner's Sons. Pp. 350. Price, $2.

The blood-covenant is a rite by which two persons absorb each the other's blood, either by drinking or by transfusion to the veins, whereby they become bound to one another in even a closer connection than that of brotherhood. It prevails in many countries—savage, barbarous, and semi-barbarous—and may be traced back to extreme antiquity. Dr. Trumbull discovers it first in Syria; then finds numerous accounts of it in the journals of African travelers and of adventurers among the North American Indians; detects it in the Norse lands of Europe and in India, and so around the world. He might also have found it a characteristic custom among the Albanians and some of the south Slavs. Going back into history he finds it still more prevalent in the olden times, and, seeking to discover it in its origins, he detects it in the rites and literature of the ancient Egyptians, and allusions upon allusions to it in the books of the Bible. Besides description and history, the purpose of his book is to investigate the meaning and symbolism of the rite. He believes that its origin, to use one of the many statements he makes respecting it, is in "the universally dominating primitive convictions that the blood is the life; that the heart, as the blood-fountain, is the very soul of every personality; that blood-transfer is soul-transfer; that blood sharing, human or divine-human, secures an inter-union of natures; and that a union of the human nature with the divine is the highest ultimate attainment reached out after by the most primitive as well as by the most enlightened mind of humanity." With savage and barbarous peoples the rite lies at the foundation of cannibalism; it is the motive of sacrifices, in which the animal is offered to the god as a substitute for the human blood. In one form the drops of blood were put in wine or other draughts and drunken: then the wine was drunken without the actual presence of the blood; whence we have the use of wine in pledges of friendship and in marriage. Among the Jews it is symbolized in circumcision; and, finally, it found its culmination in the offering of the blood of Christ, which Christians of all denominations again observe symbolically, after their Master's own institution, in the use of wine at the sacrament. These views, which Dr. Trumbull sets forth with much force and copious illustrations by references and quotations, are not a theory which he set out to prove, but are thoughts that have grown upon him as he has advanced in his work, and have been suggested by his researches; and the fact that they have been hitherto overlooked furnishes, to his mind, another illustration of the "inevitably cramping influence of a preconceived fixed theory—to which all the ascertained facts must be conformed—in any attempt at thorough and impartial scientific investigation."

Mind-Cure on a Material Basis. By Sarah Elizabeth Titcomb. Boston: Cupples, Upham & Co. New York: Brentano Brothers. Pp. 288.

The author of this work having acquired the method of curing disease which is practiced by the mind-curers, came to the conclusion that the success attending that method is due to concentration of thought, and not to the theology underlying the method. She regards it as a well-attested fact that disease, even inorganic, can be cured as well as caused by the mind or the imagination. Besides especially elaborating this theory she reviews "The Theology of the Christian Scientists"; discusses "The Single-Substance Theory," or Materialism, and the manifestations of "Mind in Animals and in the Lower Races of Men"; attempts to trace "The Origin of the Doctrine of the Immortal Soul"; and searches for "Bible Proofs of the Single-Substance Theory."

Methods of Research in Microscopical Anatomy and Embryology. By Charles Otis Whitman. Boston: S. E. Cassino & Co. Pp. 255. Price, $3.

The aim of this work is to supply in a measure a need which has been created by the rapid development of the methods of microscopical anatomy and embryology within the last few years. The contents of the volume have been arranged in two parts the first embracing methods of a more general nature, such as preservative fluids, dyes, macerating fluids, fixatives, mounting media, the microtome with its appurtenances, methods of imbedding, etc.; and the second including special applications of embryological, anatomical, and histological methods. Under the head of "embryological methods" are given, besides accounts of objects of study, notes on such points as the times, places, and best methods of collecting, breeding-habits, food, and other items of information that may aid the student in making a choice of material and controlling its supply. The part on special methods is designed to meet the wants of the beginner as well as of the more advanced student.

Report on Forestry (Department of Agriculture). Prepared by Nathaniel H. Egleston. Vol. IV. 1884. Washington: Government Printing-Office. Pp. 421.

This report is compiled from the replies to the circulars of inquiry which have been sent out to various parts of the country, asking for information respecting different points in the condition of the forests and the consumption of wood. The facts thus gathered are arranged in the shape of special reports by agents of the department, as on the collection, preservation, and planting of seeds or young trees in the prairie States; the condition of forests, timber-culture, etc., in the Southern and Western States; on the kinds and quantity of timber used for railroad-ties (from facts furnished by two hundred and eighty-three railroad companies); on the decrease of woodlands in Ohio; on the forest condition and lumber and wood trade of certain States; on the growth, etc., of trees; on the forests of Washington Territory; and on the production of maple-sugar in the United States and Canada.

The German Verb-Drill. By Adolphe Dreyspring. New York: D. Appleton & Co. Pp. 276.

Professor Dreyspring is the author of the "Cumulative Method" of teaching German, which he illustrates by the motto—*Repetitio mater studiorum*—"repetition the mother of studies." The purpose of this work is to present the mechanism of the colloquial and written languages in a series of exercises on the verbs, always lively and varied, yet subject to a well-ordered system. The author selects this part of speech as the central object of the exercises, because he believes that the office of none other is more complex, more important, and more useful in ministering to the power and intelligibility of expression. It is also the part of speech which in German as in other languages goes through more inflections and raises more difficulties in construction than any other; so that whoever masters the verb has little difficulty with anything else. The verb-drill takes the form of a lively conversation between the teacher and the class, in which a single verb being selected for the day's lesson, it is passed along in its inflections and with its combinations. The plan appears to us, looking at it from without, adapted to facilitate the study of language and make it more interesting, while it is also fundamental and thorough.

Lectures on the Principles of House-Drainage. By J. Pickering Putnam, Architect. Boston: Ticknor & Co. Pp. 125. A Guide to Sanitary House-Inspection. By William Paul Gerhard, C. E. New York: John Wiley & Sons. Pp. 145. Price, $1.25.

The "Lectures" of the former volume were delivered at the Massachusetts Institute of Technology, before the Suffolk District Medical Society and the Boston Society of Architects. Their scope is chiefly the presentation of the principles on which the drainage appliances of houses should be constructed and arranged, with criticisms of existing appliances and arrangements. The author has himself devised some new appliances, the qualities of which he describes, but always with an honest notice to the reader that he is talking about his own work. A foreign and independent judgment of the value of the lectures is given in a request which was made by the editor of the "Sanitary Record," London, for permission to republish them.

The principal aim of Mr. Gerhard's book is to instruct the householder respecting the main features of a sanitary house-inspection, particularly in the matter of searching for defects in the arrangements. First is considered the inspection of city houses as to their surroundings and soil, the cellar, yard, structural details, sewerage and plumbing, water-supply, method of garbage disposal, arrangements for warming, gas-lighting, ventilation, for exclusion of bad odors, prevention of dust, and for safety against fire; next, are articles on apartment-houses and tenement-houses, on country-houses, which, like city-houses, are treated in detail, and on summer boarding-houses and summer resorts.

Marvels of Animal Life. By Charles Frederick Holder. New York: Charles Scribner's Sons. Pp. 240, with Plates. Price, $2.

The aim of this inviting volume is to interest youth in natural history by pointing out the attractive side and so presenting its interesting features that they will go out and become investigators for themselves. It relates wholly to marine life. Many of the observations chronicled in it, the author says, "were made during a long residence upon a coral reef or atoll, some while swimming under water along the bristling coral banks that formed a characteristic feature of our tropical home, and others are the memories of many practical collecting tours in various localities." The author displays much talent in presenting the brighter sides of his pictures.

Rudder Grange. By Frank R. Stockton. Pp. 322. Price, $1.25. The Last Meeting. By Brander Matthews. Pp. 268. New York: Charles Scribner's Sons.

"Rudder Grange" is an amusing sketch of experiments in housekeeping, rather fanciful than real, we judge, which we have read with much pleasure, and can commend as all healthy and good for a leisure moment. "The Last Meeting" has a more elaborate plot and greater variety of incident, and appears to deal with sadder scenes.

The Commonwealth of Georgia: The Country, the People, and the Productions. Prepared under the direction of J. T. Henderson, Commissioner of Agriculture. Atlanta: J. P. Harrison & Co. Pp. 379. With Fifteen Maps. Price, $1.

In this work, which is published under the authority of the State, as a hand-book, the attempt is made to depict, by a series of maps, in an intelligible and acceptable way, the geology, agriculture, temperature and rainfall, water-powers, forestry, minerals, and elevations of Georgia. In the letterpress are given, with considerable detail, descriptions of the population, public institutions, government, educational establishments, newspapers, and of the fruit, grass, garden, and field products.

PUBLICATIONS RECEIVED.

Natural Gas: Its Advantages, Use, and Economies. By George H. Thurston. 1885. Pittsburg: A. A. Anderson & Son, Printers. Pp. 32.

Fifth Report of the Shell-fish Commissioners of the State of Connecticut to the General Assembly, January, 1886. 1885. Middletown: Pelton & King, Printers. Pp. 26.

Report of the Proceedings of the Illinois State Board of Health. Quarterly Meeting, Springfield, October 29, 30, 1885.

Geometrical Form of Volcanic Cones and the Elastic Limit of Lava. By George F Becker. Reprint from the "American Journal of Science." Pp. 11.

A Contribution to the Vertebrate Paleontology of Brazil, and Second Continuation of Researches among the Batrachia of the Coal-Measures of Ohio. By E. D. Cope. 1885. Philadelphia: A. E. Foote.

On Polysynthesis and Incorporation as Characteristics of American Languages. By Daniel G. Brinton, M. D. 1885. Philadelphia: McCalla & Stavely. Pp. 41.

The Physiological and Pathological Effects of the Use of Tobacco. By Hobart Amory Hare, M. D. 1885. Philadelphia: P. Blakiston, Son & Co. Pp. 86. Illustrated.

Index to the Literature of Uranium, 1789–1885. By H. Carrington Bolton, Ph. D. 1885. Washington: Government Printing-Office. Pp 36.

Remarks on a Supposed Fossil Fungus from the Coal-Measures. By Professor Joseph F. James. Pp. 10.

Saratoga Winter and Summer: An Epitome of the Early History, Romance, Legends, and Characteristics of the Greatest of American Resorts. By Prentiss Ingraham. New York, 1885. Pp. 110. Illustrated.

Forest Preservation in Canada. By A. T. Drummond. Montreal, 1885. Pp 7.

Introspective Insanity. By Allan McLane Hamilton, M. D. Reprint from the "American Journal of the Medical Sciences." 1885. Pp. 8.

Free Cities in the Middle Ages By L. R. Klemm, Ph. D. Hamilton, Ohio. Pp. 22.

Inaugural Exercises of the Henry Shaw School of Botany. Washington University, St. Louis, Mo. 1885. Pp. 24.

Report of the Committee on Indexing Chemical Literature. By H. Carrington Bolton. Pp. 5.

Cervalces Americanus. A Fossil Moose or Elk from the Quaternary of New Jersey. By W. B. Scott. Pp. 22. Illustrated.

Chemistry in the Service of Public Health. By William Ripley Nichols. 1885. Salem Press: Salem, Mass. Pp. 20.

The Fixed Idea of Astronomical Theory. By August Tischner. 1885. Leipsic: Gustav Fock. Pp. 86.

Forty-second Annual Report of the New York Association for improving the Condition of the Poor for the Year 1885. New York, 1885.

The Necessity for Closer Relations between the Army and the People, and the Best Method to accomplish the Result. By Captain George F. Brice, U. S. A. 1885. New York: G. P. Putnam's Sons. Pp. 30. 25 cents.

Price List of Publications of the Smithsonian Institution. July, 1885. No. 627. Washington: Government Printing-Office. Pp. 27.

Third Annual Report of the Board of Control of the New York Agricultural Experiment Station for the Year 1884. Albany: Weed, Parsons & Co. 1885.

Why Modern Cremation should replace Earth-Burial. 1885. San Francisco: Bacon & Co.

Astronomical Papers prepared for the Use of the American Ephemeris and Nautical Almanac. Vol. II, Parts III and IV; Velocity of Light in Air, and Refracting Media. 1885. Washington: Government Printing-Office.

The Physician's Visiting List for 1886. Philadelphia: P. Blakiston, Son & Co. Various sizes, at prices from $1 to $3.

Ventilation of Buildings. By W. F. Butler. Re-edited and enlarged by James L. Greenleaf, C. E. New York: D. Van Nostrand. Pp. 147. Price, 50 cents.

Chemical Analysis for Schools and Science Classes. By A. H. Scott White. New York: Scribner & Welford. Pp. 130.

The Idea of God as affected by Modern Knowledge. By John Fiske. Boston and New York: Houghton, Mifflin & Co. Pp. 173. Price, $1.

First Lessons in Philosophy. By M. S. Handley. New York: Scribner & Welford. Pp. 59.

Bird-Ways. By Olive Thorne Miller. Boston and New York: Houghton, Mifflin & Co. Pp. 227. Price, $1.

Men, Women, and Gods, and other Lectures. By Helen H. Gardener. New York: The "Truth-Seeker" Company. Pp. 158. Price, $1.

Railroad Transportation: Its History and its Laws. By Arthur T. Hadley. New York: G. P. Putnam's Sons. Pp. 269. Price, $1.50.

Afternoon Songs. By Julia C. R. Dorr. New York: Charles Scribner's Sons. Pp. 184. Price, $1.50.

Chemical Equilibrium the Result of the Dissipation of Energy. By G. D. Liveing. New York: Scribner & Welford. Pp. 97, with Plates.

Darwinism and other Essays. By John Fiske. New edition, revised and enlarged. 1885. Boston and New York: Houghton, Mifflin & Co. Price, $2.

Charles Darwin. By Grant Allen. 1885. New York: D. Appleton & Co. Pp. 206. 75 cents.

Physical Expression: Its Modes and Principles. By Francis Warner, M. D., Lond., F. R. C. P. 1885. New York: D. Appleton & Co. Pp. 372. Price, $1.75.

A Political Crime. By A. M. Gibson. New York: William S. Gottsberger. Pp. 402.

Elements of Universal History. By Prof H. M. Cottinger. Boston: Charles H. Whiting. Pp. 336.

Social Wealth. By J. K. Ingalls. New York: The "Truth-Seeker" Company. Pp 320. Price. $1.

The Pedigree of Disease. By Jonathan Hutchinson, F. R. S. New York: William Wood & Co. Pp. 113.

Gray's Botanical Text-Book. Vol. II. Physiological Botany. By George Lincoln Goodale. New York: Ivison, Blakeman, Taylor & Co. Pp. 534.

Poems. By Jamin Willsbro. Philadelphia: Benjamin F. Lacey. Pp. 119.

Italian Popular Tales. By Thomas Frederick Crane. Boston and New York: Houghton, Mifflin & Co. Pp. 389. Price, $2.50.

The Silent South. By George W. Cable. New York: Charles Scribner's Sons. Pp. 180. Price, $1.

A Mortal Antipathy. By Oliver Wendell Holmes. Boston and New York: Houghton, Mifflin & Co. Pp. 307. Price, $1.50.

Report of the Chief Signal Officer of the Army for 1884. Washington: Government Printing-Office. Pp. 719, with Charts.

Manual of the Botany of the Rocky Mountain Region. By John M. Coulter, Ph. D. New York: Ivison, Blakeman, Taylor & Co. Pp. 480.

Psychiatry. By Theodore Meynert, M. D. Translated by B. Sachs, M. D. New York: G. P. Putnam's Sons. Pp. 285. Price, $2.75.

The Prehistoric Palace of the Kings of Tiryns. By Dr. Henry Schliemann. New York: Charles Scribner's Sons. Pp. 385. with Chromo-Lithographic Plates, Map, and Plans. Price, $10.

POPULAR MISCELLANY.

Prehistoric Human Remains in Mexico.—Mariano de la Barcena describes in the "American Naturalist" some human remains that have been found in the hill Peñon de los Baños, near the city of Mexico, imbedded in a hard rock of silicified calcareous tufa. The cranium, with the upper and lower maxillæ and fragments of the collar-bone, vertebræ, ribs, and bones from the upper and lower limbs, are exposed, and present a yellowish appearance and the characteristic aspects of fossilization. No other fossils occur in the hill, and the age of the formation can only be estimated. The bed has evidently suffered upheaval since the bones were deposited in it, and their disordered condition is accounted for by this fact. Two facts seem at once to show that, even supposing it to be of the present age, it must be of remote antiquity. They are, the elevation of the ground above the actual level of Lake Tezcuco, and the remarkable hardness of the rock, which is different from that of the other calcareous rocks that contain remains of ceramics or roots of plants clearly modern. The stratigraphical and lithological characteristics of the ground indicate that the formation belongs to the Upper Quaternary, or at least to the base of the present geological age.

Forests of the Pacific Region.—According to our census report, the forests of the Pacific region owe their density and position to the character of the rainfall, which is heavier on the northern part of that coast than anywhere else in the United States; and their general distribution and density follow the distribution and amount of the rainfall, diminishing as we go southward into drier climates. The forests of this region are: the Northern forest, from the seventieth to the fifty-eighth degree of latitude, composed principally of white spruce and species allied to but not identical with the canoe-birch and balsam-fir of the Atlantic coast; the Coast forest, extending in a narrow strip from the sixtieth to the fiftieth parallel, and thence along the summit of the Sierra Nevada, almost to the Mexican line, composed of a few coniferous species, among which are the Alaska cedar, the tideland-spruce, the hemlock, and the red fir. Its important feature is the red-wood belt, whose heaviest growth is found north of the Bay of San Francisco, and which contains more wood than any other forest of similar extent. The forest of the western slope of the Sierra Nevada, extending from the base of Mount Shasta to the thirty-fifth parallel, is next in density, is from four thousand to eight thousand feet above the sea, and is characterized by the great sugar-pine. The forest of the Valleys is composed of scattered oaks; and the Interior forest, from the Sierra to the Rocky Mountains, is of inferior importance.

How Milk is tainted.—According to the "Live-Stock Journal," milk is most liable to be hurt by the absorption of odors when it is colder than the surrounding air. For when it is warmer, the air, warmed by the contact with it, expands, with an increased capacity for absorbing gases and moisture, and rises, carrying such odors as it may have collected along with it. Thus, cold air, though it be not wholly pure, does not contaminate milk, but tends to purify it. Milk will not become contaminated, even in the stable, so long as it is warmer than the surrounding air. The question how stable-odors get into milk is answered by the statement that they are acquired from the breath of the cow. The animal can not avoid taking in these odors, and upon entering the lungs they are forced at once into the circulation. The blood becomes charged with them, and the milk, which serves as a means of unloading the blood of its impurities as well as of its nutriment, also becomes loaded with them intensified.

Individual Enterprise in Scientific Research.—While different governments have equipped large expeditions and spent considerable sums of money to assist deep-sea dredging expeditions, a similar work has been going on in Switzerland, which has no marine and not a very plethoric treasury, by individual effort, in the study of life in the depths of the lakes. The brunt of the labor has been performed by Dr. F. A. Forel, of Morgues, Professor of Comparative Anatomy in the Academy of Lausanne, who is at home in nearly all the sciences, a man in the vigor of his age, very active and very enterprising, and acquainted with Lake Leman to its very bottom and in all its moods. He has published a considerable number of memoirs respecting his explorations, and the lessons in biology and the theory of development which they suggest, of which he takes the broadest views, and to which he has given thorough examination. His principal collaborator in the zoölogical field is Dr. Du Plessis, Professor of Zoölogy in the Academy, who has been for twelve years engaged in the determination of genera and species, and has prepared a critical table of the species constituting the deep-zone fauna. Dr. Forel has personally made soundings and examinations, besides Lake Leman, in the Lakes of Annecy, Morat, Neufchâtel, Zürich, and Constance. Professor Pavesi, of the University of Pavia, has explored the lakes of the canton of Tessin and Northern Italy. Dr. Asper, of the University of Zürich, has dredged in the lakes of Zurich, Wallenstadt, Egeri, Zug, the Lake of the Four Cantons, Lugano, Como, Klönthal, Silse, and Silvaplana. Some of these lakes are situated high upon the Alps, and are consequently of interest in the study of the vertical distribution of species. Dr. Imhof, of Zürich, has also examined several lakes, and contemplates extending his studies over a considerable geographical area. August Weissman, of Fribourg-in-

Brisgau, has also published some works on the inhabitants of the Lake of Constance.

Family-Schools of Housekeeping.—A writer in the "Pall Mall Gazette" who has herself been trained in that way proposes, as a means of putting an end to the troubles about poor servants and bad housekeeping, that the German plan be adopted of sending every young girl after she has finished her school education, and before she is "out," to learn housekeeping. This every girl in Germany does, be she the daughter of nobleman, officer, or small official. She goes direct from school into a family corresponding with her station in life. Those who are rich go where they are paid highly, and are in "good family," so that they are enabled to live well and have good cooking and great variety. No one is taken into one of these establishments for less than a year, so that every month a new branch is learned—one month the preserving of fruit in season, the next laying-in of apples and vegetables for winter use, preserving of eggs and butter, etc. These girls are taught everything, from washing up dishes, sweeping and polishing the floors, clear-starching and ironing, dusting and cleaning ornaments, cooking, laying the table, waiting, polishing the silver and glass up, to decorating the table with flowers and fruit. Great is the ambition of the pupil to hear that her taste and management are the best. Combined with these duties are those of keeping the household linen in repair and learning plain sewing. Thus the young girl gets experience in household affairs. Though the pupils have to learn everything, servants are kept in these establishments, and in their turn are taught by the advanced pupils, who have learned from the mother of the family. This accounts for the excellent housekeeping in Germany, where comfort is combined with economy and the pleasure of having everything precise and clean. The labors of the day are over at midday, that being the dinner-time, when everybody is at liberty for study, needlework, or amusement till time for preparing for supper. There are many families in England who can not afford to keep servants enough to do well all that has to be done. In these families they have to train servants, not being able to afford to keep trained ones. Why not, in these cases, train young ladies (who would also be companions to the daughters)? They might pay something for the instruction, and so put something into the teachers' pocket, while they would also work for her, and at the same time reap information, which they could again impart, and so train good servants, who are at present so hard to get. Mistresses are unable to teach, never having been taught themselves. Thus they are dependent on servants; for when they find fault they are unable, either in cooking or other matters, to point out the mistake or show the correct way. Servants, knowing this fact, are independent and rule the house, and the "mistresses" must submit. The German system of living with a family and learning by experience how to manage a house is far better than either cooking-schools or lectures on the subject, as a greater variety of things are learned, and they are done in a more refined and economical way.

"Rages" in Surgery.—A part of the Presidential address of M. Verneuil at the recent meeting of the French Association consisted in a spirited and somewhat sarcastic protest against the prevalence of fashions, or "rages," as they are colloquially termed, in surgery. When he began his career, tenotomy was the rage, and tendons, ligaments, and muscles were divided subcutaneously in all parts of the body. A little later "resecomania" flourished, especially in Germany and England, so that some surgeons reckoned their resections by the hundred. Nowadays, when a specialist introduces an operation all specialists follow suit, but with a variation in the shape of the new instrument, so that, "if a museum of operative medicine were founded, immense cases would be necessary to exhibit all the lithotomes, urethrotomes, hysterotomes, and other 'tomes,' comprising small unnamed instruments, intended, I believe, to divide strictures of the nasal duct—strictures which, be it said without bitterness, hardly ever exist, or are in places where they have no need of being divided when they do exist." Gynæcology and ophthalmology compete for honors in this department, and the palm must be given to the former, for, apart from cauterizations, etc., of the cervix, it has given rise to an Emmet's operation, Battey's or Hegar's operation, an Alexander's operation, etc. The reviews and journals speak of them and praise them, so that a gynæcologist who has no "cases" to produce is little thought of. In the same strain M. Verneuil criticised other measures recently in vogue, and hinted that most of them would in process of time become as disregarded as the once prevailing fashion of an iridectomy preliminary to cataract extraction. Much had been made of late years, he said, of extirpations of the larynx, of the pharynx, of the stomach, of the uterus, of the kidneys, etc., and he asked, "How many patients have been cured thereby? How many have derived any benefit whatever from these terrible undertakings? Barely ten per cent. For these I admit that the operation has been of service, but for the ninety others can its abuse be denied? Given a hundred cases of disease," he added, "at a certain period one half are operated upon; twenty years later not more than one fourth are submitted to operation. If the results of the two series are equally successful, I conclude that, of fifty of the operations in the first series, twenty-five at least were superfluous."

Mediæval English Law.—A collection of records of English criminal cases of A. D. 1221 has recently been published, in which may be found numerous illustrations of the condition and peculiarities of the law of the period. In a case where the persons charged with a triple murder had fled and could not be held, it was recorded that "Englishry was not proved, therefore there are three fines." This refers to a rule made by the Conqueror, for the protection of his followers, that the hundred or township in which a foreigner was slain should be fined if the slayer was not produced. On the strength of this, the lawyers invented a tradition that every one should be considered a foreigner till it could be proved that he was an Englishman; and they took care that this should not be an easy thing to prove. In Gloucestershire, where these trials took place, three witnesses had to be produced, two on the father's and one on the mother's side. No woman's testimony was admitted. Consequently, in a great many cases, where probably there was no reason to believe the victim to have been a foreigner, "Englishry was not proved," and the death-fine was exacted. Prisoners not caught in the commission of the offense seem to have had the privilege of declining to be tried, when they enjoyed the possibility of escaping punishment. One John de la Mare, who had killed a miller with a stone, refused to be tried by a jury, saying he had been in the war with King John, and had done harm to many people. He was not produced when he was wanted, and his securities were fined half a mark apiece. A father and son, suspected of murdering a person who had been their guest, denied the charge, and refused to put themselves on their country. The jury, corresponding to our grand jury, however, declared that the son and his mother had committed the murder, and decided that the father should be released on bail, while the others should be kept in prison. The records of the trials offer several instances of the old custom of levying deodands. Robert Sprenghose fell from his horse and was drowned. The value of the horse, two marks, was assessed as deodand. One Osbert fell from his horse and was drowned in the Severn; the horse had no value, and no deodand could be assessed. "William Miel fell down dead as he drove the plough of Richard Sarg, his master, and Richard Witepirie, who was with him and held the plough, fled in a fright; but he is not suspected by twelve jurors, who declare on their oath that this happened by maladventure, and that the man had the falling-sickness." The justices decreed: "If Richard returns, he is to be left in peace. The coroner has forty pence of the said Richard's chattels. These are a deodand, and are to go to the house of Llantony." The power of levying deodands gave opportunities for abuse, which, with other opportunities of a similar tendency, the sheriffs were not slow of improving to their own profit.

Salt Lakes of the Murghab Valley.—In the Murghab Valley, Afghanistan, are two lakes of solid salt, which Captain Yate has ridden over and described. One, from which the Tekke-Turkomans of Merv get their supplies of salt, is in a valley about six miles square, which is surrounded by a steep, almost precipitous descent, impassable for baggage-animals except by a single road. The bed of the lake, which is about fourteen hundred and thirty feet above the sea, is one solid mass of hard salt, perfectly level, and covered by only an inch or two of water. To ride over it was like riding over ice or cement. The bottom was covered with a slight sediment, but, when that was scraped away, the pure white salt shone out below. No one has ever got to the bottom of the deposit. The second lake is the one from which the Saryks of Penjdeh take their salt, and is about eight hundred feet above the sea. The salt in this lake is not so smooth as in the other one, and does not look so pure. It is dug out in flakes or strata, generally of some four inches in thickness, and is loaded into bags and carried off for sale without further preparation.

Production of Beet-Sugar in Germany.—The consular reports to our Department of State show that the beet-sugar industry in Germany has made great progress during the last twelve years. The exportation of this sugar only began in 1860, but it has been fostered by the Government through the grant of drawbacks that really amounted to bounties till it has undergone a remarkable development. In Pomerania, while in 1871–'72, 38,000 tons of beets were manufactured into 3,000 tons of sugar, in 1882–'83, 7,700 tons of sugar were obtained from 84,000 tons of beets. It is estimated that there are now 525,000 acres of land under beet-cultivation in Germany; and it appears that there were, during the year 1882–'83, 358 factories in operation, as compared with 343 in the previous year, and that they produced 835,164 tons of raw sugar, against 599,722 tons in 1881'–82. The taxes paid by the industry amounted to $35,000,000 as compared with $25,085,000. It is expected that for 1883–'84 there will be found an increase of at least fifteen new factories over those in operation in 1882–'83. As compared with the year 1871–'72, in that year 2,251,000 tons of beets were used to produce 186,412 tons of sugar, while in 1882–'83, 8,747,000 tons of beets were used, producing 835,164 tons of sugar. The quantity of beet-root used to produce a pound of sugar has diminished, under increased skill in the manufacture, from about twelve pounds to a fraction over ten pounds.

The Harmony of Colors.—M. Chevreul, the chemist, although in his hundredth year, is not too old to discuss the interesting question of bonnets and millinery. A black bonnet, he says, with white, pink, or red feathers or flowers, suits a fair complexion. A dead white hat is only suitable for florid complexions, whether blondes or brunettes. Gauze crape or tulle bonnets suit all complexions. A white bonnet for a blonde should have white or pink flowers; blue is still better. Brunettes should avoid blue, and rather choose red, pink, or orange. Light blue bonnets are especially suitable for fair persons. They may be trimmed with white flowers, or even yellow or orange, but not pink or violet. For dark persons who venture to wear a blue bonnet, yellow or orange is indispensable. A green bonnet sets off a pale or slightly colored complexion. A pink bonnet should not be too near the face, but should be separated by the hair, or by a white or green inside trimming, the latter color especially. White flowers, with an abundance of leaves, produce a good effect on pink. A dark-red bonnet is only suitable for persons with a highly colored complexion. Avoid yellow or orange bonnets. Violet is not to be recommended unless separated from the face, not only by the hair but by yellow accessories also.

Estimating the Age of Trees.—Mr. John T. Campbell, of Rockville, Indiana, records in the "American Naturalist" some of the results of his observations on the age of forest-trees as determined by their rings of growth. He regards the rings as capable, when correctly interpreted, of giving the true history of the tree, and showing the dates of prosperity and adversity in its career. The amount of growth between the rings is not determined by the character of the particular season in which each year's growth is made, as is generally believed, but by other conditions, such as the provision of top and branches and the presence or absence of rival trees competing with it for air, light, and moisture. He found stumps of trees of the same species, the same size, and presumably the same age, standing within twenty feet of each other, on the same kind of soil, cut down the same year, and, so far as he could judge, subject to the same conditions throughout, "one showing a large ring where its neighbor would show only an average one, and in some few cases they showed the opposite." While he can not account for the spasmodic production of single rings of large or small growth, interspersed here and there among those of average size, he has been able to trace successions of large or small rings to some plausible cause. In making some surveys, he had had occasion to refer to two trees which had been marked in the Government surveys of fifty years before, as "witness-trees," to aid in identifying corners. Both were described in the field-notes of those surveys as ash-trees three inches in diameter. One had grown to be eighteen inches in diameter; while the other had added only a half inch to that dimension, but the required rings of growth could be plainly seen under the glass. The former tree had had a good soil on level ground, while all of its adult rivals had been blown down by a tornado which had passed over the spot. The latter tree "stood in dissolved sandstone for soil, on the top of a narrow ridge, between three large oaks, which robbed it of sunlight and rain, and nearly all the soil nourishment. It had but five or six small branches for a top, and but few leaves to a branch; under such conditions it did well even to exist." Mr. Campbell read the history of two oaks as it was revealed to him by the rings and the configuration of the ground. One sprouted from the seed in 1502; the other, twenty feet distant from it, in 1594, or ninety-two years afterward. "In 1731 a tornado from the northwest blew down a still older oak, which in its fall struck against and greatly damaged the top of the one born in 1502." The two younger trees had been freshly cut down when the author examined them. "Their stumps were about four feet across, and there was not over an inch difference between their diameters, though ninety-two years difference in their ages. The younger had a large, healthy top, no broken or dead limbs, and it had put on rings of growth from the beginning of more than average size. The older one had been injured in its branches by the fall of the still older tree before mentioned (in 1731), and for fifty-seven years had put on very small rings of growth, . . . when a new set of branches developed to take the place of the damaged ones, and the rings began to increase in size and gradually attained to the average. I examined their tops, which coincided with what has gone before. There were the peculiar knots in the top of the older one where dead limbs had rotted off and were healed over. During this delay the younger oak caught up with the older one in size. The size of a tree is a very uncertain indication of its age." Mr. Campbell examined one tree that was six hundred years old, and learned from it that "at the age of about two hundred years it had some ill fortune which caused it to form about one hundred small rings. It then regained its health and formed normal rings for about one hundred and forty years, when another mishap caused small rings till within the last fifty years, when it was putting on fair growths again."

Uses and Nature of Physiological Experiment.—Dr. H. Newell-Martin has replied to an accusation made against him in the London "Zoöphilist," of practicing cruelty in his physiological experiments on living animals. First, he responds to the charge that the experiments are useless, saying: "Every one is aware that in very many cases severe fevers result in death. It is well known to most medical men that most such deaths are due to failure of the heart. This failure is caused by too rapid beat, the organ not getting rest enough between its strokes for nourishment and repair. This quicker beat might be due to any of four or five possible causes. . . . To ascertain which of them was mainly responsible for it, and thus throw light upon the proper means to be adopted to save life, was the object of my research; an object which, I am proud to say, I in large measure attained." In regard to the amount of pain inflicted in the experiments, his first endeavor was "to put out of action, *to kill*, all parts of the body but the heart and lungs. These do not possess consciousness, and are incapable of suffering pain when the brain is dead." In doing this "no pain whatever was inflicted, except, in some, the slight smarting due to hypodermic injection of morphine. Two experiments were performed under curare, a drug the power of which to destroy consciousness is still in doubt. . . . The reason for making these was that chloroform, ether, and morphine, act themselves on the heart; and, finally, to clinch the question as to the influence of hot blood on that organ, it was necessary to experiment on a heart which had not been exposed to possible alteration by the action of any one of them. In these cases pain was stopped as soon as possible by tying the carotids, and this took three or four minutes. . . . If," Professor Martin adds, "the precise truth concerning every physiological experiment made in this country be brought before the public immediately after its misrepresentation in any anti-vivisection journal, our science is safe. Truth can not hurt it. Publicity will swell the ranks of its students. Legislation impeding our work need not be feared. Human and animal disease and suffering will be diminished, life prolonged, and the world made better as well as happier, through our researches. If we fail to use every effort to protect and promote those researches, are we not guilty toward our fellow-men and the lower animals dependent on us?"

Who shall try the Dynamiters?—In an article on "Dynamiting and Extra-Territorial Crime," Mr. Francis Wharton, LL. D., has aimed to show that the prosecution of persons sending dynamite abroad for criminal purposes belongs to the states from whose soil the dynamite is sent. Authorities on the law of nations agree in maintaining that when, in one sovereignty, overt acts are taken toward the commission of a crime in a foreign land, jurisdiction exists both in the place of preparation and in the place of execution. A similar doctrine has been repeatedly held in England, as growing out of the common law; and British courts have enforced the obligation to punish persons, whether British subjects or foreigners sojourning in the country, who prepare in the United Kingdom attacks to be made in other countries. The same principle has been observed in the United States. The particular question Mr. Wharton discusses is, whether, in such crimes as dynamiting, the jurisdiction should lie in the Federal courts or in those of individual States. The foreign country sees only the nation; but, within the nation, what entity should answer the responsibility? The General Government has already taken cognizance of offenses of this class where sovereigns are concerned, as it might well do, by virtue of its functions in maintaining diplomatic intercourse with their courts. But to hold the same attitude with respect to common crimes against common persons, or the general public, would be to trespass upon the duties and prerogatives of the States. It would, moreover, tend to give those offenses and the measures taken against them a political aspect, and to call in all the complications of political feelings and prejudices. The question should be made to appear as a matter of social order, affecting the homes and lives of the whole community from which the jury to decide upon it is drawn. To make it a matter of national concern would at once divide the jury according to their national sympathies. "It would be otherwise, however, when the question is, whether the law permits dynamiting, or whether it will stop dynamiting at the place where it is started, which is the only place where it can be stopped."

Hindoo Cosmogony and Physics.—The Rev. Sumangala, chief-priest at Adam's Peak, in Ceylon, has recently published an account of the opinions of Hindoo astronomers on the form and attraction of the earth. Bhaskara, who flourished in the twelfth century, thought that the terrestrial globe, composed of land, air, water, space, and fire, had a spherical form, and, surrounded by the planets and the orbits of the stars, maintained itself in space by its own power. This, he says, is in fact demonstrated. Lands, mountains, gardens, and houses cover the earth as pollen covers the flower of Kadamba, and serve as the homes of men, Raksasas, Devas, and Asuras. He rejected the idea that the earth rested on anything else, for the obvious reason that, if another support were needed, there would be no end to the supplementary supports. Therefore we shall have to admit a final equilibrium somewhere; why not accept it at once? "Is not the earth one of the forms of Siva? As heat occurs naturally in the sun and fire, cold in the moon, fluidity in water, and hardness in the stone, so mobility exists in the air. Every object has its own properties, and the properties implanted in some objects are wonderful." Bhaskara believed that the earth, possessing an attractive force, drew to itself everything heavy in the atmosphere surrounding it, whence those bodies fall to it. "But," he said, "how could the earth fall into the ethereal space, since that space is equal on all sides?"

Opposing Views of Arctic Exploration.—Admiral Bedford Pim, in a recent lecture on "Arctic Exploration," related a conversation he had had with Secretary of War Lincoln, on the utility of the perilous adventures undertaken for that purpose. The Secretary asked him, "What is the good of the journeys to those regions, and how can you defend the fearful loss of life, unnecessarily, as I think, thrown away?" The admiral, in reply, recalled the biblical command to replenish the earth and subdue it, and asked: "How can we possibly do that if we are not even acquainted with its land and water? And then, with respect to the loss of life, more men have been slaughtered in one skirmish than have been lost in the polar expeditions for four hundred years; in point of fact, the percentage of loss of life in the polar regions is less than in any other sea employment. Then, some of the best examples of seamen, both morally and physically, have been men trained in all the hardships and dangers and difficulties of the polar regions. I can conceive of no better school. . . . The spirit of enterprise is strongly encouraged by these expeditions. And, depend upon it, if we men are such arrant cowards, and so forgetful of our duty, as to abandon research until somebody's flag is planted on the north pole, the ladies will do it." Lieutenant Danenhower opposes further attempts to penetrate the polar area for the present. While nothing useful is to be attained there in the way of geographical discovery, it is well to weigh the comparative importance of investigation in that branch in other parts of the world. British America has not been fully explored, though it possesses an area more than eight times that of the central polar region. Much work needs to be done in Central Africa, the Himalayas, New Guinea, and other parts of the world. For hydrographic research, it is not necessary to go to these regions, but the best field for operations lies below the eightieth parallel. As for the interests of meteorology, "there is no special reason for believing that the meteorological phenomena of the central polar regions differ essentially from those observed near the borders, and the possible advantages to be gained would not alone justify further exploration." Neither is any great advantage to be gained for magnetic and auroral observations. The magnetic poles are known, and are in or near already explored regions, and the most brilliant auroral phenomena are observed near them. In short, we know nearly as much on all these subjects, or can study them as well in the regions we have already opened, as we could learn by going to the pole. But "the time may come in the progress of civilization and advanced knowledge when the exploration of all the present unknown parts of the torrid and temperate zones shall have been completed, and it will then be the occasion to explore the ice-locked regions of the north pole"; and, "after having served with one Arctic expedition, and having devoted seven years to the study of the subject, . . . I unhesitatingly record myself as opposed to further exploration of the central polar basin, with our present resources. The gradual extension of observatory stations in the interest of meteorology, magnetism, and other scientific branches, should be made, but national support should not be given to another polar expedition."

Meteorology of the Congo.—Mr. A. von Danckelmann, a German meteorologist, has been making observations at Vivi, in the country of the Congo, and reports some curious results. During about a year that he stayed there the barometrical column did not vary more than ten millimetres; even the passage of tornadoes seemed to produce no greater effect upon it. The year is divided into rainy and dry seasons. During the latter, from May to October, no rain falls, but the earth is occasionally moistened by the depositions from fogs. From November to April heavy showers of short duration prevail, and the water falls, in portions, sometimes as high as one hundred and two millimetres — about four inches — in two hours. Long, fine rains are unknown. The country is visited by cyclones, but, while storms passing to the north of the station turned the vane in a contrary direction to that of the hands of a watch, those passing it to the south turned it in a direction corresponding with theirs. The natives burn the tall prairie-grass in the dry seasons, causing fires that last for a long time, and produce considerable meteorological effects. The air is constantly loaded with smoke, while cumulus clouds are formed over the fires and emit lightning with thunder. One of the most remarkable meteorological phenomena of the region is the existence of a southwest wind, which, beginning at sunset, blows all night till sunrise with such force as to raise large and dangerous waves on the river.

An Affectionate Mother-Spider. — The *Clubiories* are minute, grayish-yellow spiders with a dark brown stripe along their back, which build their nests among growing oats, generally using two or three stalks. M. Ernest Menault, a French naturalist, looked into one of their nests and found there a great number of little eggs in various stages of development. The mother-spider was frightened and much excited on observing his proceedings, and endeavored vainly to collect her treasures again. From another nest M. Menault tore away the protecting web, but the diligent mother soon set herself to work spinning a patch to cover exactly the breach he had made. He repeated the experiment several times, and the spider as often came to repair the mischief. Another spider, the *lycosa*, gathers her eggs, as soon as they are laid, into a little ball, which she then wraps with a thin but compact and solid covering of silky tissue. This ball, stuck to her web, she drags after her wherever she goes. When pursued, she runs as quickly as the weight of the egg-ball will let her, but, if any attempt be made to seize the cocoon, she stops at once and tries to get it back, when she shows considerable courage and fighting capacity. If the cocoon is destroyed, the *lycosa* will retire into a corner, and in a short time die. When the eggs are hatched the mother-spider takes her young upon her back, and has them always with her. "It is impossible," says M. Menault, "to behold without emotion this little creature, naturally so quick and jerky in all her movements, acquire a motion so much gentler when carrying her treasures. She carefully avoids all dangers, only attacks easily won prey, and abandons all chance of obtaining anything the capture of which would necessitate a combat that might cause her to drop the young ones, which press and move by hundreds round her body." Bonnet tells of a *lycosa* whose egg-bag was captured by an ant-lion, which nevertheless refused to leave it, preferring to be swallowed up and share the fate of her eggs. When taken away by force, she persisted in returning to the scene of danger.

Race Characteristics of the Jews.—Dr. A. Neubauer read a paper recently, before the British Anthropological Institute, on "Race Types of the Jews," the purport of which was to show that there had been considerable intermixtures in the Hebrew race from the time of Abraham down. Joseph married an Egyptian and Moses a Midianite; David was descended from a Moabitess, and Solomon was the son of a Hittite woman. So we read of the non-Jewish women in contact with the Israelites, and undoubtedly the proselytes increased the mixture of races by marrying Jewish women. Moreover, some quite marked differences prevailed in the middle ages, and still exist, between the Jews residing in different nations. Mr. J. Jacobs, in a paper "On the Racial Characteristics of Modern Jews," took a different view. Regarding only the Askenasian Jews, who form more than nine tenths of the whole number, he pointed out as among their characteristics fertility, short stature as compared with Europeans, and narrow chests, brachycephalic skulls, darker hair and eyes than those of any nation in Northern Europe (though nearly one fifth of the Jews have blue eyes, and they have nearly twice as many red-haired individuals as the inhabitants of the Continent), and a peculiar cast of countenance. He pointed out that the purity of the race depended on the number of proselytes made by the Jews in ancient and mediæval times. The earlier proselytes, before the foundation of Christianity, were mostly fellow-Semites, and would not affect the type, while the numbers made afterward were too small to modify the race. A considerable number of Jews, the Cohens, were not allowed to marry proselytes, and must consequently be tolerably pure. Mr. Jacobs's general conclusion was therefore in favor of the purity of the Jewish race.

The Elm-Leaf Beetle.—The entomological division of the Department of Agriculture has published an account, prepared by Dr. Riley, of the elm-leaf beetle (*Galeruca xanthomelæna*), which has committed serious damage upon the elms in many States during the past few years. It is an importation from abroad, and fortunately gives its attention mostly to foreign species of elm, the common native species, *Ulmus Americana*, being generally exempt from its ravages. The injuries it commits are severe about one year in three, while they are relatively light in the intervening years. It works its destruction from May to August, and prefers the warm side of the tree. The most effective remedies against it are the ordinary arsenic washes and powders, and these appear to injure the tree as well as kill the insect. Their effect is also worst on those species and varieties which suffer most from the ravages of the beetle. In administering the poison, it is well to anticipate the appearance of the insect, so as to prevent its getting a start.

Conditions of Success in Life. — The physiological conditions of success in life, according to Dr. James T. Searcy, of Tuscaloosa, Alabama, in his address before the State Medical Association, consist chiefly in the vigorous and healthy action of the brain and nervous system. Therefore the structural integrity and functional capacity of the brain are most important matters, and how to preserve and improve them are vital questions. Hence the author believes, "if we can discover the ways in which brain capacity is improved, we will have done a great deal, and, if we can state the ways in which it is lowered, we will have done a great deal." The excellent man will not only show his ability to take in, to understand, but he will also show it in knowing what to take in, in his ability to select for a purpose. "The successful man possesses ability not only to learn, but to verify his learning and to deduce his conclusions correctly, and execute them tenaciously. The simply erudite man is not the successful one. He must be capable not only in his receptive ability, but also in his adjusting and emissive abilities. This often puts the man who is simply the scholar at such disadvantage in the presence even of the unlettered man of 'common sense.' 'Common sense' may be defined to be the inherent excellence of capacity in all three of the departments of brain-action. He need not be an 'educated' man to show this trait, but if he is educated his inherent 'common sense' tells all the better. He learns well and properly, he reasons well and properly, and he executes well and properly."

How Woods preserve Moisture. — M. Woeikoff, an eminent Russian observer, asserts, in a recent article in Petermann's "Mittheilungen," that the office of forests in diminishing evaporation can not be explained by the lower temperature or the greater humidity which are known to exist under their shadow. The most important factor contributing to the result is the resistance opposed by woods to the winds, the force of which being greatly reduced under the trees, the air is changed more slowly, and consequently the moisture is less readily carried away. Documents which have been collected at Nancy, in France, show that the vicinity of a forest increases the quantity of rain. It would seem that in Central Europe, where the difference between the temperature of the ground and air within the forest and that of the open is but little in the winter, the forests would have slight influence on precipitation at that season. Nevertheless, the forests receive more water than the open spaces in winter, because of the lowness of the clouds combined with the resistance that the woods offer to the moist west winds. Rain-water is stored in the moss and herbage of the woods, to be consumed by the vegetation during the dry season. A striking illustration of this fact is given in a forest on the western coast of the Caspian Sea, where the vegetation is very luxuriant, although it never rains except in the fall and winter. M. Woeikoff has also observed that forests depress the temperature of the neighboring regions. Thus the normal temperature ordinarily increases as we go from the sea toward the interior in Western Europe and Asia; but the presence of a forest compensates for the rise in temperature, so that there are places far from the sea that are cooler than the shore itself. This is the case in Bosnia, where the summer is five or six degrees cooler than in Herzegovina, on account of the woods.

NOTES.

According to "Wood and Iron," of the four hundred and thirteen species of trees found in the United States, the perfectly dry wood of sixteen species will sink in water. The heaviest of these is the black iron-wood of Southern Florida, which is thirty per cent heavier than water. Others of the best-known species are the lignum-vitæ, mangrove, and a small oak found at elevations of from five to ten thousand feet in Western Texas, Southern New Mexico, and Arizona. All the species are natives of Florida or of the dry interior Pacific region.

Artesian wells have been in operation in the Sahara from a very remote period, and new ones have been opened by the French in the Algerian portion of the desert with considerable success. At the same time a large increase has taken place in the number of palm and other fruit trees. The limit of the capacity of the veins to be found at the usual depth of one hundred metres appears, however, to have been reached at last, for the borings made since 1881 show a diminished yield of water. The French wells, moreover, are harder to clean when they are stopped up by sand than the Arabian ones, on account of their smaller bore; and it is believed that new wells will have to be made, of larger caliber.

M. Bocion, of the Cantonal Industrial School of Lausanne, Switzerland, reports the discovery in Lake Leman of a bright-green moss growing in the bottom of the lake, on the calcareous rocks, two hundred feet below the surface. No other moss has been found at so great a depth under water; and how chlorophyl could have been so richly developed so far from the light is a problem.

Professor Purdie, having analyzed a specimen of the milk of the porpoise, gives the following as its composition per hundred parts: Water, 41·11; fat, 45·80; albuminoids, 11·19; milk-sugar, 1·33; mineral salts, 0·57. The substance set down as milk-sugar was too small in quantity for accurate examination, and is regarded by the analyst as very probably some albuminoid matter. The most remarkable point about the composition of the milk is the large percentage of fat which it contains, a constituent of food of which the cetaceans would naturally require a larger proportion than ordinary mammals do. The milk was yellow and thick, and had a fishy smell; and its specific gravity differed but little from that of water.

Mr. E. T. Newton has described the remains of a gigantic bird—the *Gastornis Klaasensii*—found in the Lower Eocene of Croydon, England, which indicates a species as large as the Dinornis of New Zealand. The most perfect tibiotarsus, when complete, must have had a length of at least twenty inches, and its trochlea is three and a half inches wide, while in another specimen the trochlea is four inches wide. The anserine affinities of Gastornis, as regards the tibiotarsus, are confirmed by the detailed comparison of the Croydon bones with recent forms.

According to M. Dinnik, a Russian traveler in the Caucasus, it is the custom among the Ossetes (one of the peoples of the country) for the lucky sportsman or treasure-finder to deposit some part of his spoil in the sanctuary of Rekom, in the Zéa Valley, and that temple has become a kind of curiosity-shop. The outside of the building is decorated with horns, from the examination of which M. Dinnik has been able to solve a question respecting the geographical range of two species of goats. The funeral mounds of Ossetia also furnish offerings to Rekom, which are brought to it by persons who dig in them for the gold ornaments they may find deposited there. Armlets, rings, knives, and lance-heads of the bronze period are among the curiosities of this strange mountain museum; but other uses than that of consecration appear to be found for articles of gold.

Tests made with small squares of different kinds of wood, buried an inch in the ground, have shown, according to the "Garden," that birch and aspen decayed in three years; willow and horse-chestnut in four years; maple and red beech in five years; elm, ash, hornbeam, and Lombardy poplar in seven years; and oak, Scotch fir, Weymouth pine, and silver fir, to a depth of half an inch, in seven years; while larch, juniper, and arbor-vitæ were uninjured at the expiration of the seven years.

M. Gustav Le Bon believes that a good place to look for the origin of cholera may be in the volatile ptomaines, or alkaloids of putrefaction emitted by organic substances in the later stages of decay. The ptomaines developed in the earlier stages of putrefaction appear according to his researches to be usually solid or liquid, and much less dangerous than those which escape at a later stage, and which, being volatile, have thus far eluded examination. But these last, when taken into the system by the breath, produce deadly effects. M. Le Bon's conclusions on this subject have been derived from observation of the progress of cholera at Kombakonum, in Southern India.

J. Graber has made experiments with animals of the classes of vertebrates, articulates, mollusks, and worms, from which he has determined that the sense of color and the power of perceiving light are more widely distributed than has generally been supposed. The variations in the sense of color among animals are very great.

Sulitjelma, on the Norwegian frontier, in latitude 67½°, 6,000 feet high, and Sarjektjåkko, in Swedish Lapland, 1,000 feet higher, have in turn been put forward as the highest mountain in Sweden. They both have now to give place, on the testimony of Dr. Svenonius, to Kebnekaisse, in Lapland, which is 7,300 feet above the level of the sea.

Professor W. Mattieu Williams indicates as probable sources of nitrogen in soils, and serving as food for plants, the dead bodies of insects, excreta of living insects, invisible spores, microbes, and particles of organic fluff which are always floating in the air and liable to adhere to the moistened surface of the soil and of the leaves of the growing plants. To prove the existence of such deposits on leaves, moisten a white pocket-handkerchief and gently rub it over the surface of the leaf of any growing plant in dry weather. No matter how far from the smoke of towns, the soiling of the handkerchief will show a deposit of solid matter, of which a considerable proportion is organic.

Examination in the color-blind test is now obligatory on candidates for masters' and mates' certificates in the British mercantile marine. Failure to pass the test does not now prevent the candidate receiving his certificate, as it did when the examinations were first instituted, but the certificate is given with the indorsement, "The holder has failed to pass the examination in colors." This examination is not yet made obligatory on pilots and men on the "lookout," and this ought to be regarded as a serious omission; for collisions are certainly more apt to occur off the coasts, when the vessels are under the charge of pilots, than out at sea, where they have been given over to the masters and mates.

Dr. Hertel, of Copenhagen, has published the results of a sanitary inspection of the schools of that city, from which it appears that about one third of the pupils are sickly. With respect to the girls, the fact is brought out that "between the ages of twelve and sixteen the number of sickly girls increases till it exceeds that of healthy by ten per cent, except at the age of fourteen, when the figures are equal." Dr. Hertel also made inquiries into the condition of some German schools, and brought out the fact that in a single group of them three fourths of the pupils of the highest class have defective eye-sight.

The Japanese have promulgated a patent law, which seems to be a compilation of various provisions selected from the laws of other countries. The term of protection is fifteen years. Articles "that tend to disturb social tranquillity, or demoralize customs and fashions, or are injurious to health," and medicines, are excepted from its benefits. Among the conditions on which patents are granted, it is prescribed that the articles must have been publicly applied within two years, and that the patents shall become void when the patented inventions have been imported from abroad and sold.

M. E. Senet claims to have employed a process for electroplating with aluminum, by which the deposition of that metal is effected as easily as is that of copper or silver. He uses a saturated solution of sulphate of aluminum and a solution of chloride of sodium, keeping them separated by a porous vessel. Under the action of the galvanic current a double chloride of aluminum and sodium is formed, which decomposes at once, the aluminum being set free and depositing itself at the negative electrode upon whatever object may be placed there to receive it.

Mr. J. D. Hyatt, in his studies of compound eyes and multiple images, remarks as a curious peculiarity of the eyes of the horse-fly that the lenses of the upper and anterior part are much larger than those situated below a median line, the larger facets having at least twice the diameter, or four times the superficial area, of the smaller. The larger lenses form pictures at a plane considerably above the focal plane of the smaller ones. Thus these insects are furnished with eyes of two varieties, corresponding to our long sight and short-sight spectacles; in other words, with telescopic and microscopical eyes, the telescopic looking upward and forward and the microscopical downward.

Professor D. P. Penhallow, having studied the relation of annual rings to the age of trees, concludes that the formation of rings of growth is chiefly determined by whatever operates to produce alternating periods of physiological rest and activity. In cold climates the rings are an approximately correct, but not always certain, index of age; but in warm climates they are of little or no value in this respect. The influence of meteorological conditions in determining the growth of each season is most important, particularly with reference to rainfall. Periodicity in rainfall corresponds with periodicity in growth.

Some of the German journals describe a plant which has lately been discovered to have electrical properties. It is called the *Phytolacca electrica*. It gives a slight electric shock to the hand when its stalk is broken, and affects the magnetic needle, disturbing it considerably if brought very near. Its energy varies during the day, being strongest at about two o'clock in the afternoon and falling away to nothing at night.

M. A. de Abbadie states that the mercurial bath at his observatory in France, about a mile and a half from the Spanish frontier, was subjected to extraordinary and almost continuous agitations during all of last winter, beginning with the 1st of December. The oscillations sometimes reached 30″ and were on one day, the 23d of December, as frequent as four in a second. He believes there was a connection between the oscillations, or the cause of them, and the earthquakes in Spain.

A lecture on fish-culture, delivered recently in Hull, England, by Mr. W. Oldham Chambers, was illustrated by object-lessons of living specimens of the white-fish and other foreign species.

OBITUARY NOTES.

James Macfarlane, of Towanda, Pennsylvania, author of a valuable work on the coal-fields of America, and of the "Geologists' Traveling Hand-book," died suddenly on the 11th of October. He was engaged at the time of his death in the revision for a new edition of the "Geologists' Traveling Hand-book," in which are given descriptions of the geological formations along all the railroad routes of the country.

Mr. Thomas Bland, an eminent conchologist, died in New York on the 20th of August last, in the seventy-seventh year of his age. He was born in England, and inherited a taste for conchology from his mother. He removed to Barbadoes in 1842, and thence to Jamaica. He became superintendent of a gold-mine in New Granada in 1850, whence he removed to New York in 1852. Here he became associated with Mr. W. G. Binney in the study of our land-shells and in the publication of works which have greatly elucidated the subject. The catalogue of his scientific writings contains seventy-two titles.

Edward Henri von Baumhauer, Secrery of the Dutch Scientific Society at Haarlem, and editor of its "Archives," died last year, in the sixty-sixth year of his age.

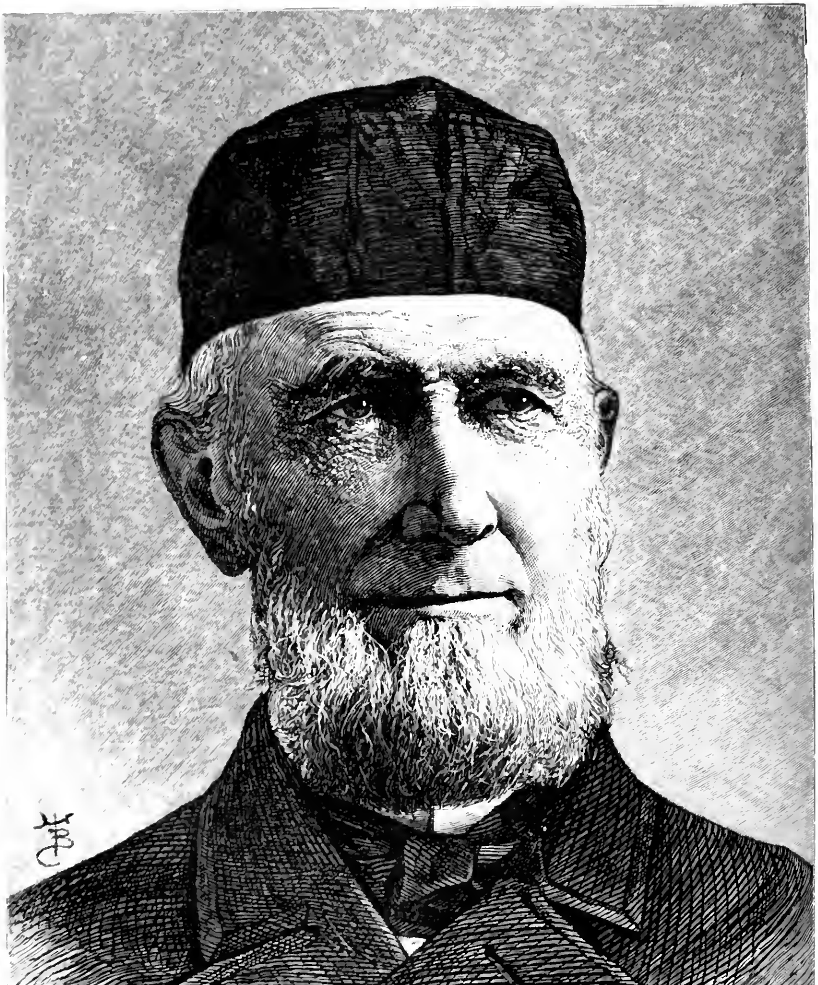
Dr. J. J. Baeyer, a distinguished authority in geodesy, founder of the European *Gradmessung*, and president of the Central Bureau of the society, and of the Royal Prussian Geodetic Institute, died September 10th, aged ninety-one years.

W. Woodbury, the inventor of the Woodbury type process for multiplying photographic pictures, died in Margate, England, September 5th, from the effects of an overdose of laudanum, which he was accustomed to take to allay sleeplessness. He was fifty-one years of age. Notwithstanding the value of his inventions and the great use that has been made of them, it is said that he left his family poor.

Dr. Nicolas Joly, honorary professor in the Faculty of Sciences and in the Medical School of Toulouse, France, died in that city October 17th, in the seventy-fourth year of his age. He was best known, perhaps, by the controversy which he, with MM. Pouchet and Musset, carried on with M. Pasteur in 1863, on the theory of spontaneous generation, from which M. Pasteur came off with all the honors of victory. He was the author of numerous publications of merit in zoölogy and prehistoric ethnography; and was one of the founders of "La Nature," and a frequent contributor to its pages.

Dr. Thomas Davidson, F. R. S., of Muirhouse, Midlothian, Scotland, the highest authority on British fossil Brachiopoda, died at West Brighton, England, October 16th, in his sixty-ninth year. Up to 1871 he had published forty-nine books and papers, chiefly devoted to his specialty in paleontology. He received medals from the Royal and Geological Societies, and from Sir R. Murchison, and a testimonial from the Paleontographical Society in recognition of his labors.

Charles Robin, a French physiologist, who introduced the study of histology into his country, died early in October last, in his sixty-fifth year. In announcing his death to the French Academy of Sciences, the president of that body remarked upon the fact that M. Robin had not been able to accept the new facts added by his pupils to the science to which he had given a start, and that he had never been "converted to the doctrines of bacteriology."



JAMES B. EADS.

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THE IMPROVEMENT OF EAST RIVER AND HELL GATE.

By General JOHN NEWTON,
CHIEF OF ENGINEERS, UNITED STATES ARMY.

THE East River is a most important factor in the commercial prosperity of the cities of New York and Brooklyn. Its shores form a large portion of the water-front of both cities, and afford space for many miles of docks. Its channel is scoured by strong tides, which keep it permanently free from shoals of sand and mud. It connects the waters of New York Bay with those of Long Island Sound, and is the most important avenue of coastwise trade in the United States. Since the partial removal of the obstructions in Hell Gate, a very heavy foreign trade has taken this route, notably the petroleum traffic, and, with the completion of the designed improvements, the East River will afford a convenient access for transatlantic steamers. The value of this entrance to New York Harbor will be still further enhanced by the opening of the Harlem River to the Hudson, the preparations for which are now in progress.

The unobstructed navigation of the East River would also have an important bearing on the question of national defense in case of war with a foreign state. It would render the blockading of the port of New York a task of doubled difficulty, and would open the shores of Long Island to our larger war-vessels and to ironclads.

For these reasons the problem of removing the obstructions to the free and safe passage of vessels through the East River has engaged an increasing degree of attention for a considerable time. These obstructions were all accumulated within a short distance of one another, in the narrow strait called Hell Gate, and were occasioned by numerous reefs of rocks encroaching on the channel and the violent currents to which they give rise, making navigation extremely hazardous for all kinds of vessels.

A clear idea of the nature of these obstructions and dangers in the original condition of the strait is given in the report of Lieutenant-Commanding Davis, who, with Lieutenant-Commanding David Porter, made a survey of the place in 1848. "The strength of the current," he says, "is such that sailing-vessels can only stem its force or escape from it by a commanding breeze; but, as the main course of the flood-tide keeps the middle of the Eastern Channel, it is most secure for vessels which are coming from the westward with the tide to place themselves in the middle of the stream and follow its direction. This plan, however, is inadvisable for any but small vessels, on account of the rocks, the Pot and Frying-Pan, which lie in or very near the mid-channel, are in the way both going to the eastward and westward, and have but little water on them at low tide. There is also a reef called Way's Reef, which lies in the course followed by steamboats principally when coming from the eastward against a strong flood. It is their custom to keep close round Pot Cove, and run up under Hallet's Point, by which they avoid the strength of the flood. In this part they find an eddy-current in their favor. But on the ebb the greatest danger arises from the divergence of the current, when the ebb branches off into three directions to take the course of the three channels—the main Ship-Channel, the Middle Channel, and the Eastern Channel. The safe navigation depends here upon deciding sufficiently soon at the point of separation which channel shall be taken; and the neglect to do this, or a loss of control over the vessel for any reason, frequently results in being carried on the Gridiron. When a vessel that has attempted the Eastern Channel finds herself carried toward the Gridiron, her only chance for safety is to run for the Middle Channel, which is narrow and made precarious by the middle reef, the outer rock of which is the Negro Head. The Gridiron is, owing to the strong set of the tide upon it, the most dangerous reef in the passage. The reef known as Bread and Cheese, on the eastern end of Blackwell's Island, is also very dangerous. Vessels are liable to go on it in the flood, when it is covered, by getting into the eddy near it with a light wind. The chief danger is on the ebb, and from the same reason that makes the Gridiron dangerous—i. e., the strong set of the tide in that direction."

The reefs (see map) known as the Gridiron, Flood Rock, Hen and Chickens, and Negro Head, are all essentially parts of one reef, which is designated as the Middle Reef. Between this reef and the reef which is marked by the projections of the Great and Little Mill Rocks, is situated the Middle Channel. The Eastern Channel is included between the Middle Reef and Hallet's Point. The South or Main Ship Channel lies to the west of Great and Little Mill Rocks, and between them and Rhinelander's Reef. The two surveying-officers, while agreeing as to the desirability of removing or mitigating the obstructions, made different recommendations respecting the manner in which they should be dealt with.

Lieutenant-Commanding Davis recommended that Pot Rock, the Frying-Pan, and Way's Reef be blasted and scattered, and that the Middle Channel be improved by blasting, so as to make a clear channel of sufficient depth for common vessels and steamboats. As the removal of the larger reefs seemed at that time impracticable, he advised that they be faced with sea-walls or piers rising four feet above high water, and provided with spring fenders such as are used at the ferry-docks, so adjusted as to guide vessels coming in contact with them into the channel-ways. Lieutenant-Commanding David Porter, not regarding the deepening of the Middle Channel as practicable, advised that it be filled in with docks, and recommended the removal of a part of the reef at Hallet's Point.

No efficient method was suggested for removing the rocks it was proposed to take away, further than to blast them and leave the fragments to lie where they might fall, or to be washed away by the currents. This method would obviously make but a slight impression on the larger reefs.

A process of surface-blasting was first applied by M. Maillefert in 1851. His method consisted simply in placing upon the rock a charge of gunpowder, usually of 125 pounds, contained in a tin canister, and exploding it by means of the voltaic current. The weight of the water resting upon the charge served to increase the effects of the explosion. No means were provided for removing the broken rock except by breaking it up by successive explosions till it was fine enough to be carried away by the currents. M. Maillefert's operations resulted, by the use of 620 charges containing 74,192 pounds of powder, at a cost of $13,861, furnished through Mr. Merriam, in removing from the rocks to which they were applied the projecting prominences of small area, but were of little effect when, after reaching the main rock, a considerable extent of surface had to be dealt with. The depth of water was increased, on Pot Rock, from 8 feet to 18·3 feet; on Frying-Pan, from 9 to 16 feet; on Way's Reef, from 5 to 14 feet; and on Shell Drake, from 8 to 16 feet. Bald-Headed Billy and Hoyt's Rocks were blown into deep water. The depth on Diamond Reef was but slightly if at all affected, and no effect was produced on Hallet's Point Reef. In 1852, Congress having appropriated $20,000 for the removal of obstructions, Major Fraser, by Maillefert's method, increased the depth over Pot Rock to 20·6 feet, adding 2·3 feet of water to the 18·3 Maillefert had gained, with the expenditure of $6,837. The decrease in the ratio of returns for expenditure was occasioned by the increased surface of the rock, due to increase of depth.

In 1856 an advisory council to a commission on the removal of obstructions in Hell Gate recommended a plan which, as to its general features, was substantially the same as that which Lieutenant-Commanding Davis had proposed in 1848. Instead of Maillefert's process of surface-blasting, they recommended that of drilling. This would have had to be done from within a diving-bell, which was impracticable because of the certain disturbance of the apparatus by currents, and the liability to collisions from passing vessels. All of the plans so far tried or proposed seemed to have been limited to removing the smaller rocks lying in the channel; the possibility of clearing away the larger reefs was not yet conceived.

In 1866 the department instructed me to make an examination of Hell Gate, and to present a plan and estimate of the operations necessary to improve its navigation. A report was submitted in January, 1867, with an estimate for removing the reefs by blasting, after drilling the surface from a fixed platform above the water. In this plan, or in whatever plan might be decided upon, it was considered essential that the drills, which, to avoid interference from currents, were to be worked within iron tubes reaching from the platform to the rock, should be attached to a framing kept absolutely fixed while the drilling was going on; and that the divers or the machinery necessary to handle and remove from the bottom the rock blasted should be protected from violent currents. It was proposed to accomplish the latter object by means of a system of floats and iron curtains so arranged as to constitute a dam protecting a space of 160 feet long and 40 feet wide, within which the work could go on uninterrupted. Another machine was alternatively suggested, embodying the same principle, to consist of an iron caisson or cylinder, pointed at the ends, open at the top and bottom, and having self-adjustable legs to accommodate themselves to the irregularities of the rock, and to support it and keep it level. The top of this structure was to be above the level of the highest tide, and to be framed over so as to form a platform, on which the machinery could be placed, and from which the operations could be conducted. It was important in constructing the machine to have it adaptable to all the rocks on which it was intended to operate, whatever their size and the shape of their surface, and that it be perfectly stable against the action of the currents without being unwieldy in size. It was furthermore considered necessary to furnish it with a protection against collisions which were sure to occur from the fleets of vessels passing daily, and certain to destroy it, with a loss of life and much property, if it were not protected.

These conditions were fulfilled in the steam-drilling cupola-scow (Figs. 1 and 2). The scow is built very heavy and strong; is provided with an overhanging guard, faced with iron, surrounding it as a protection against collisions; and has a well-hole 32 feet in diameter. The caisson or dome is a hemisphere 30 feet in diameter, composed of a strong iron frame covered with boiler-iron. It is open at the bottom

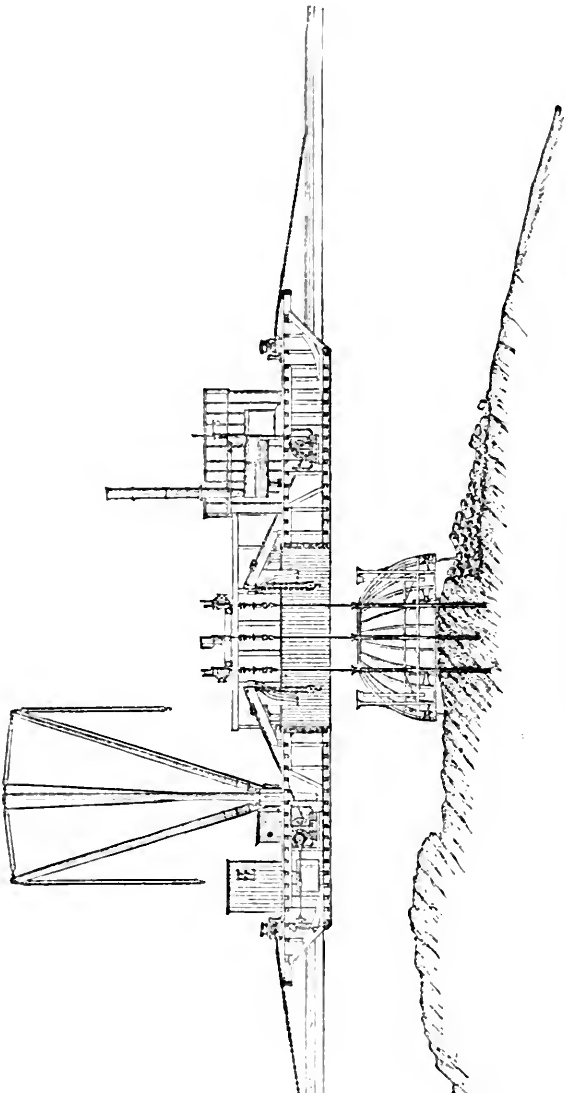


Fig. 1.—Sectional Elevation.

and top, and is provided with self-adjustable legs so arranged as to be all let go together after it is lowered. This caisson or dome is simply a framework affording a fixed support to the drill-tubes, twenty-one in number, through which the drills operate. It is connected with the scow by four chains, communicating with four hoisting-engines, by

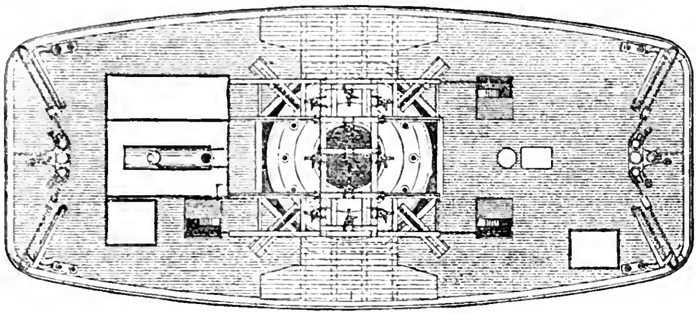


Fig. 2.—Deck Plan.

which it is lowered or raised. The scow, having the dome swung by chains, is anchored over the rock to be operated upon, by as many anchors as are required to hold it against all the currents. The diver then goes down to examine the bottom and see that the position is favorable. The position of the scow is changed by lengthening and shortening the moving chains with capstans. When all is fixed, the dome is lowered close to the bottom and established by letting the legs go to adjust themselves on the bottom. The chains which connect it with the scow are unslung, and flexible connections are made between the tops of the drill-rods and the piston-rods of the driving-engines. These connections must be flexible, because, the dome being fixed on the bottom, while the scow holding the drill-engines is certain to swing for short distances back and forth, the connections, if rigid, would be broken. When the drill-holes are completed and ready to be charged, the dome is lifted up, and the scow, carrying the suspended dome, is swung off from the spot to a safe distance (the length of which depends on the amount of the charge), without casting loose the moorings. The charges of explosives, in tin cases of different lengths to suit the varying depths of the drill-holes, are carried to the spot upon a small scow, whence the diver descends to insert them into the holes; the cartridges are handed down to him, already attached to leading wires by the men on the scow; and he is guided from hole to hole by lines connecting the stoppers or plugs inserted in the holes. The scow is withdrawn, the leading wires are connected with the battery, and the explosion is made with invariably certain effects.

To secure satisfactory results in the breaking up of the rock, the drill-holes should be six or eight feet apart, five to six inches in diameter, and should reach to about four feet below the level to which it is desired to break the rock. The broken rock is removed by means of a steam-grapple. Provision was made for the attachment of curtains, or dams, of chain-netting, rope-netting, or canvas, to the bottom of the dome and to the steam-grappling apparatus, as a shield against currents, but it was not found necessary to use anything of the kind.

Operations with the steam-drilling scow were completed January, 1880, upon Diamond Reef. The rock was covered with a large accumulation of loose material which had first to be removed with a dredging-machine, after which all of the ledge that was uncovered was attacked. The holes were drilled from seven to thirteen feet deep, four and a half inches in diameter at the top, and three and a half inches at the bottom, and were charged with from 30 to 55 pounds each of nitro-glycerine.

Coenties Reef was worked upon in alternation with Diamond Reef in 1871 and completed in 1875.

In 1872 work was commenced on Frying-Pan, and there is now twenty-two feet at low water.

Work was prosecuted on Pot Rock in Hell Gate from August 5 till December 28, 1872, during which period the scow was much exposed to collisions, of which sixteen took place. In one of them the colliding vessel was drawn under the scow and carried off the dome, which was afterward recovered, considerably damaged, in eighty feet of water. The depth on this rock is now twenty-four feet.

Way's Reef, over which the original depth of water was five feet, having already been cleared by the application of M. Maillefert's process of surface-blasting in 1851 and again in 1869, to 17½ feet, was operated upon from August 4, 1874, to January 20, 1875, and the depth of water was increased to 26 feet at low water. The rock within the 26-feet curve measured 235 feet in length by 115 feet of maximum width. To accomplish the result two hundred and sixty-two holes were drilled to an aggregate depth of 2,130·4 feet, sixty-five drill-blasts and sixteen surface-blasts were made, and 16,792¾ pounds of nitro-glycerine and 38½ pounds of dynamite were consumed.

For the removal of Hallet's Point Reef it was determined to employ a process of undermining the rock by tunnels and galleries, from which mines should be exploded to break up the whole mass of the rock at once. Similar processes had already been suggested by General Alexander, United States Engineers, and A. W. von Schmidt, C. E., for the removal of Blossom Rock, in San Francisco Harbor. The reef in question (Fig. 3) was in the shape of a semi-ellipse, extending 720 feet in length along the shore, and to a distance of 300 feet in breadth into the channel; and the cubic contents necessary to be removed, in order to secure a depth of 26 feet at mean low water, amounted to 53,971 cubic yards. The reef was dangerous, not only in itself, but also on account of the eddies to which the tidal currents gave rise on either side of it, according to their direction. Operations were begun here in July, 1869, for the construction of a coffer-dam between high and low water marks; and in the following October the excavation of a shaft, conforming in shape to that of the dam, and 32 feet in depth, was begun. Thence tunnels radiating through the rock, with transverse galleries, 25 feet apart, to connect them, were excavated till thirty-five tunnels and ten galleries were constructed, having an aggregate length of 7,426 feet. The tunnels were from 17 to 22 feet high and from 9 to $12\frac{3}{4}$ feet wide at the shaft, and tapered off in both dimensions as they went out; and the galleries were from 12 feet high by 9 feet wide down to smaller dimensions.

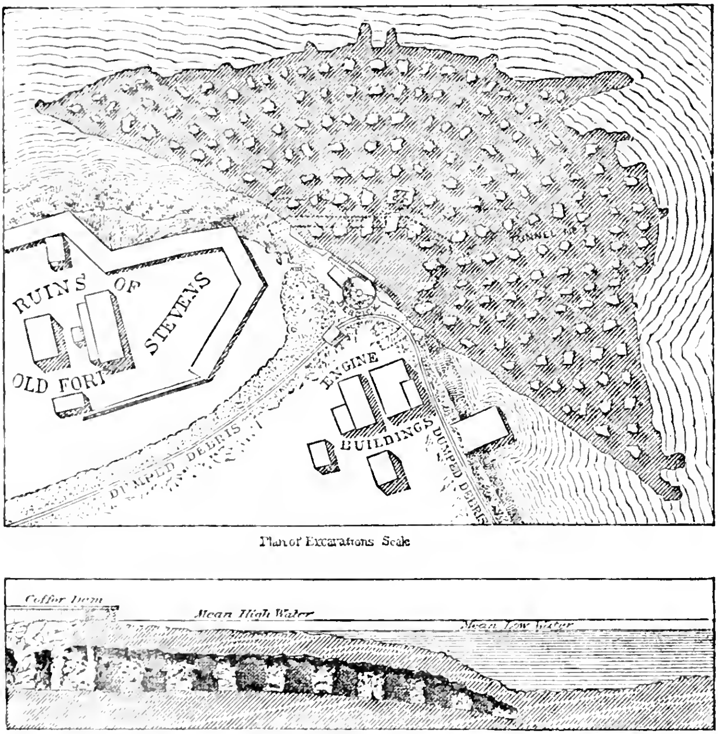


Fig. 3.—Hallet's Point.

The work of excavation was commenced in the latter part of October, 1869, and terminated in June, 1875. Deducting the time lost by suspension of work due to the exhaustion of current appropriations, the actual period consumed in this work was four years and four months. The appropriations were, under the law, devoted to many reefs in the East River and Hell Gate besides the one at Hallet's Point; the result being that the work was rarely prosecuted in full force at the latter place. With a more generous grant of money the time consumed until the explosion, which amounted in all to six years and ten months, could have been reduced to four years.

As soon as the excavation was finished, the work of drilling holes in the roof and piers, to be afterward charged with explosives, was begun. At the completion, March 25, 1876, there had been drilled in the roof 5,375 three-inch, in the piers 1,080 three-inch, and 286 two-inch holes; the total length of holes drilled being 56,548 feet of three-inch and 1,897 feet of two-inch holes.

The proximity of the reef to habitations at Astoria, Ward's Island, and Blackwell's Island, made it necessary to devise a system of explosion which, effecting the work of demolition, would at the same time do no damage to life and property. The atmosphere and the rock being the mediums through which the shock would be transmitted, it was essential that the waves propagated through these should be as small as possible.

It was evident, in the first place that, if to each charge its full capacity of useful work in breaking up the rock was assigned, regard being likewise had to the superincumbent weight of water, no external effect of moment would be perceived in the atmosphere. In the second place, it was evident that the magnitude of the rock-wave would depend greatly upon the quantity contained in individual charges, that is, if eighty pounds were required for the individual charge, the vibration of the rock would be much greater than if these charges did not exceed twenty pounds. It was known that eighty-pound charges of nitro-glycerine, fired in numbers of twelve to twenty, did not cause a destructive wave. Again, the reef, after the excavation, being connected with the rock only through the piers and outer edge of the roof, it was inferred that the shock propagated in the rock would be due mainly to the charges necessary to disrupt the piers and roof from their connection with the bed-rock, and not to the charges to break up the roof and piers. The cubic contents of the roof and piers were 63,135 cubic yards, and the amount of explosives—

Rend-rock	9,127	pounds
Vulcan powder	11,853	"
Dynamite	28,935	"
Total	49,915	

Being at the rate of 0·79 pound to each cubic yard.

The explosives were placed in tin cartridge-cases. The number used was 13,596, 87 per cent being 22 inches and the remainder 11 inches in length. The number of holes charged was 4,427.

The system consisted of 3,680 mines and 23 batteries. Each battery assigned to 160 mines, which were divided into eight groups of twenty each. The mines of each group were connected in continuous series, and a lead and return wire to the battery closed the circuit.

The mines were fired at two hours fifty minutes P. M., September 24, 1876, and there were no injurious shocks in the atmosphere, in the water or underground.

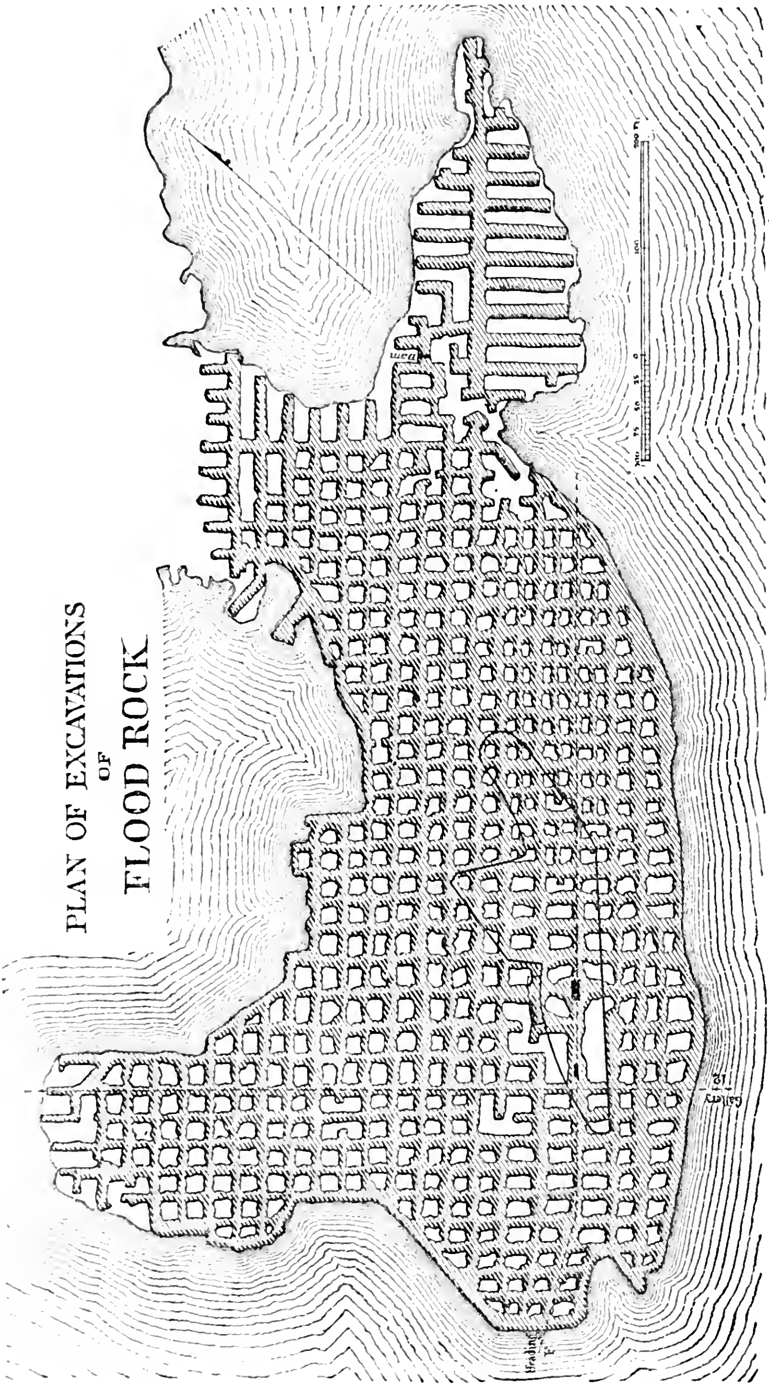


Fig. 4.

The new facts obtained by this experience are:

1. That an unlimited amount of explosives distributed in blast-holes in moderate charges, proportioned to the work to be done, thoroughly confined in the rock, and tamped with water, may be fired without damage to surrounding objects.

2. That an unlimited number of mines may be simultaneously fired by passing electric currents through the platinum-wire bridges of detonators.

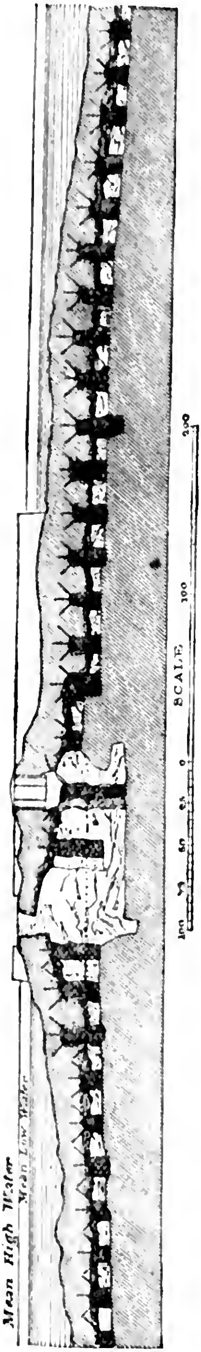


Fig. 5.—Section through Heading F.

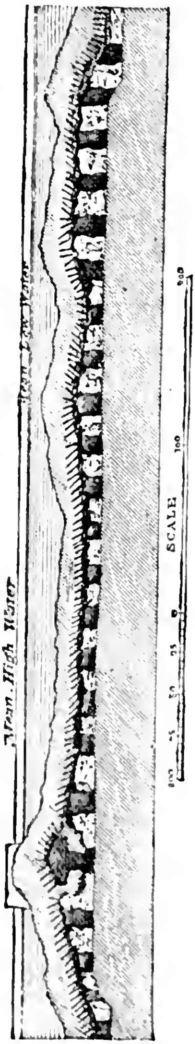


Fig. 6.—Section through Gallery 12.

Substantially the same methods as those which had proved efficient upon the Hallet's Point Reef were applied to the larger and more formidable Flood Rock. Two shafts were sunk from the ridge of the rock (Fig. 4), whence the whole nine acres of the reef—extending 1,200 feet in length and 602 feet in width—was undermined by two sets of parallel galleries, running at right angles to one another. The piers of rock left between these galleries to support the roof of the mine were about fifteen feet square and twenty-five feet apart from center to center. The roof of the cross-galleries, which ran at right angles to the lines of stratification, was blasted down as thin as it would be safe to leave it (Figs. 5 and 6). Considerable risk was incurred in this part of the work, from the danger of the rock crumbling, and from the uneven and uncertain thickness of the roof. The average thickness was 18·8 thick, and the minimum thickness ten feet. The exact thickness could not be ascertained beforehand, for no soundings could distinguish between the solid rock and a concretion of bowlders and shells formed upon it. Had the excavations at any time broken into a large seam, the mine would have been flooded by the in-rush of the water, and all the work and probably many lives would have been lost. Occasionally small seams were met and had to be dealt with. One seam was ten inches wide and a hundred feet long; another one, from one to four inches wide and 400 feet long, extending clear across the reef, carried 350 gallons of water a minute. The latter was dealt with after protecting the completed part of the work by building across the gallery a door capable of withstanding the pressure of the water. The seams were all walled, as fast as they were opened, with Portland cement. The total length of the galleries was 21,670 feet.

The galleries were excavated to depths varying with the uneven surface of the reef. The roof was then drilled with holes for the reception of the explosive cartridges, with which the rock was to be finally blown up. The holes were slanted upward at angles varying from 75° to 45°, and were made from eight to ten feet deep—except where the existence of seams open to the river made it impossible to obtain the depth wanted—and of sufficient capacity to receive a rigid two-and-a-half-inch cartridge throughout their entire length.

The holes were charged with rack-a-rock as the principal explosive—a substance formed by mixing 79 parts of finely-ground chlorate of potash and 21 parts of di-nitrobenzole. It is one of the safest explosives to handle, and the ingredients are absolutely inert when kept separate, and they need not be mixed till just before loading the cartridge; it has $109\frac{3}{10}$ per cent the strength of No. 1 dynamite, when fired under water, and costs but a little more than half as much. The mixing was done in small batches on Great Mill Rock, in a lead-lined trough, and the explosive was packed at once into cartridge-cases $2\frac{1}{4}$ inches in diameter and 24 inches long, made of copper 0·005 of an inch thick. To prevent the corrosion of the copper by the chemical action of the sulphureted water running through some of the drill-holes, the cartridges were protected by being dipped in melted resin, beeswax, and tallow. The cartridges, after being loaded, were soldered with a steam-heated soldering-iron; were removed as fast as they were filled, and were carried to the mine in boxes containing twenty each; so that the amount of mixed explosive above-ground at any one time was never enough to do more than local damage in case of an accident. These cartridges were inserted in the drill-holes, one after the other, till the holes were filled, the last cartridge in every case being filled with dynamite, with its end left to project about six inches, so that it might receive the full effect of the shock from the initial charges connected with the battery. This cartridge is represented in Fig. 7, and is 15 inches long and $2\frac{1}{4}$ inches in diameter. In its forward or projecting end is inserted a small copper shell filled with fulminate of mercury. The other cartridges, charged with rack-a-rock, represented in Fig. 8, are 24 inches long by $2\frac{1}{4}$ inches in diameter, and are provided at their forward ends with a fulminate primer which is inserted after they are filled. This primer is shown in half size in Fig. 9, and consists of a fulminate exploder similar to that shown in Fig. 7, in a copper tube containing an ounce of No. 1 dynamite. The

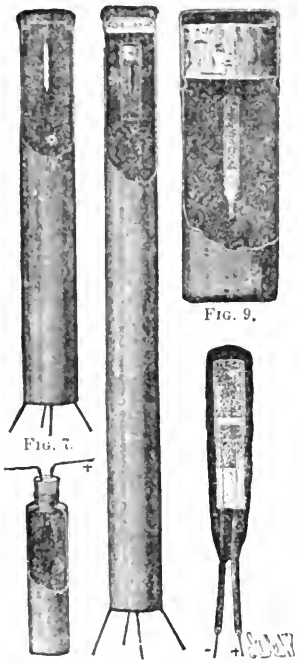


FIG. 7. FIG. 9.

FIG. 11. FIG. 8. FIG. 10.

CARTRIDGES AND MINE-EXPLODER.

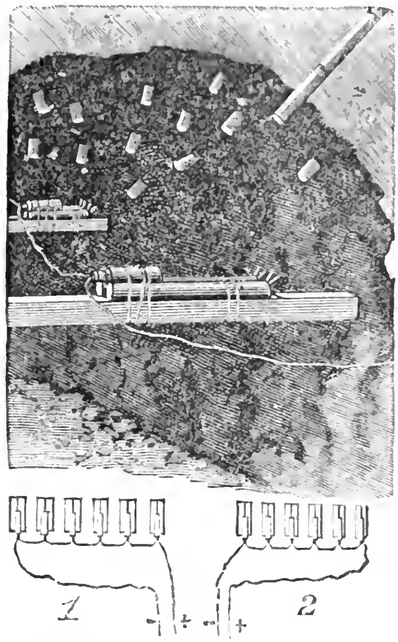


FIG. 12.

ARRANGEMENT OF THE CHARGES IN THE MINES.

cartridges are secured in the holes by the wire springs shown at their lower ends; and the dynamite cartridge is also wedged in with wooden wedges. Fig. 10 shows the mine-exploder, the position of which in the mine is illustrated in Fig. 12. It consists of a brass cylinder, eight inches long by two in diameter, filled with dynamite. Inclosed within the dynamite is a fuse, shown half size in Fig. 10, the wires from which pass through a divided cork in the mouth of the brass cylinder. It consists of a copper tube nearly filled with 30 grains of fulminate of mercury. Fitting in the open end of this tube is a second tube containing sulphur, through which pass the two conducting-wires, they being held firmly in place by the sulphur. The inner ends of the wires are united by a small platinum wire. The ends of the wires are then surrounded with fulminate, and the two parts of the tube are put together, that containing the wires slipping within the other. The entire fuse is then covered with gutta-percha. The passage of an electric current through the wires heats the platinum bridge to redness, and causes an explosion of the fulminate.

The number of pounds of rack-a-rock put into drill-holes was 240,399; of dynamite, 42,331; total, 282,730 pounds. There were 11,789 drill-holes in the roof and 772 in the pillars, and their total length was 113,102 feet, or more than twenty miles. The whole amount of rock to be broken by the final blast was 270,717 cubic yards, covering an area of about nine acres.

The primary charges, the office of which was by their detonation to produce the explosion of the charges in the drill-holes, were placed along the galleries at intervals of twenty-five feet, and arranged as shown in Fig. 12. They were placed on timbers extending from wall to wall in each of the galleries, and consisted of two twenty-four-inch dynamite cartridges like those already described lashed to the timber, with one of the "mine-exploders," also already described, bound upon them. The entire mine was divided into twenty-four independent circuits. Within each of twenty-one of these circuits were twenty-five fuses or mine-exploders, while three circuits contained twenty-two fuses each. A wire from the battery on the surface of the rock at the mouth of the shaft led from one fuse to the next, until the twenty-five fuses were in the same electrical circuit, and thence back to the battery. So far as was practicable, adjacent charges were put on different circuits, so that if any circuit failed through any fault in the connections, an explosion of its charges would still be insured through the sympathetic action of the adjoining charges. The whole number of these primary charges was 591. Some of the circuits were nearly a mile long.

The fuses prepared for this work had a resistance of 1·73 ohms cold, and 2·76 ohms at explosion. To fire a single fuse, 0·205 ampères were required; to fire a series, 0·615 ampères. A factor of safety of two was used, and double this current was sent through every fuse at the final blast. The battery consisted of sixty cells, all coupled in one series, each of which had an electro-motive force of 1·95 volts and an internal resistance of 0·01 ohms. The plates were six inches by nine inches—four carbon and three zinc plates in each cell, separated by a quarter of an inch. The ordinary bichromate solution was used. The poles were constituted of two large mercury-cups, into one of which were dipped the twenty-four lead wires, while the twenty-four return wires terminated in a third cup. Between this third cup and the remaining pole of the battery stood the apparatus for closing the circuit. It consisted of a stout iron cup containing mercury, in which sat a thin glass tumbler also partly filled with mercury. Two large strips of copper connected the mercury in the iron cup with one pole of the battery, and that in the glass with the cup containing the return wires. To close the circuit through the fuses it was only necessary to break the tumbler so as to let the mercury in it mix with that in the iron cup. To do this at the proper moment, a one-quarter-inch iron rod four feet long, terminating at the top in a small round disk, stood with its point in the bottom of the glass. It was long enough to pass through the roof of the battery-house. A thirty-grain platinum fuse, connected with a small battery at Astoria, was laid on the disk and stuck on with a lump of wax. It had been previously determined by experiment that the blow struck by this fuse on exploding, and transmitted by the iron rod, would be so sharp as to completely pulverize the tumbler and yet not splash the mercury.

The mine was flooded by two siphons of twelve and sixteen inches respectively, in fifteen hours and a half, ending at 3.30 A. M., October 10th. The explosion was set for 11 A. M., October 10th, but the interests at stake were so great, and the details to be looked after to avoid every chance of miscarriage so numerous, that, in spite of the most energetic effort, everything could not be made ready and *tested* in time to fire at the appointed moment. The explosion did not actually take place till 11.13. This delay caused some confusion in the seismoscopic observations.

The whole area of the reef was shattered. The plan of making the excavations large enough to swallow all the *débris* of the reef and leave a channel deep enough, without further operations, already abandoned at Hallet's Point as more expensive than dredging up the broken rock, was never entertained at Flood Rock. Hence the sensational view, which many persons expected to witness, of a sudden disappearance of the rock, was not seen. Though the charges all exploded at the same instant, the time and the appearance of the effect above the water-surface varied according to the strength of the rock and the depth of the water. There was no loud report and no dangerous shock. The breaking of some panes of glass and the shaking down of a few bricks and loose ceilings constituted all the damage that was done.

Pending the awarding of a contract for dredging, the work of removing the rock was begun with a scow belonging to the Government as soon after the explosion as possible. From fifteen to thirty tons of rock were removed daily by being hoisted out after having been slung by divers on chains. A contract has been let for the removal of 30,000 tons of the rock at $3.19 per ton, the contractor to do his own surface-blasting. This is less than the price for which rock was removed on similar terms at Hallet's Point. The contractor has two grapples at work, and is removing an average of about 120 tons a day. As a whole, the cost of mining a cubic yard of rock has been reduced $34\frac{2}{3}$ per cent from the cost of doing the same work at Hallet's Point. The total cost of the work done on Flood Rock, including the final blast, amounts to $2.99 per cubic yard of the whole amount of rock broken, or $5.66 less than the cost of breaking Hallet's Point. A considerable part of this gain will, however, be expended on the proportionately larger amount of dredging to be done. The net result, however, will show an improvement of not less than 30 per cent, and probably more. The total cost of the final blast at

Hallet's Point was $81,092.24; at Flood Rock it was only $106,509.93, though the blast was 5·6 times as large. These results together indicate that a great advance has been gained in the economy with which the whole work was carried on; and the progress with the dredging gives promise that an 18-foot channel, 400 feet wide, over the worst part of the reef, may be cleared out by spring. If the funds are supplied as needed, the dredging can all be completed in three years.

The accounts of the observations of the shock of the explosion, have been tabulated by General Abbott, as follows:

STATION.	Distance in miles.	Interval of transmission.	Velocity in miles per second.
West Point, N. Y.	42·34	10·9	3·88
Hamilton College, N. Y.	....	45·0	3·88
Pearsall's, L. I.	16·78	6·6	2·54
Bay Shore, L. I.	36·65	13·0	2·82
Patchogue, L. I	48·52	15·4	3·15
Goat Island, R. I.	144·89	58·8	2·46
Harvard Observatory, Cambridge, Mass.	182·68	19·8	0·83
Princeton, N. J.	48	251·0	0·94

It seems that the speed of the oscillation-wave is the greatest through an uninterrupted rock formation.

Fig. 13 is a bird's-eye view of the reefs of Hell Gate, taken from a model constructed from the preceding map and from surveys of the Engineer Department. The white margin around the shores and reefs represents the parts between mean low water and twenty-six feet below it, the level to which all reefs obstructing navigation are to be reduced.

Negro Point (1): on this reef no work has been done. It is to be undermined and cut off on a line with the Sound-entrance wharf. Holmes Rock (2) and Hog-Back (3) are simply to be finished with a sea-wall. Frying-Pan (4) has been reduced to the level of twenty-four feet below mean low water. Way's Reef (6), Shell Drake (7), finished to the full depth of twenty-six feet. Hallet's Point (8), the rock shattered by the explosion has been entirely removed to the depth of twenty-six feet. The projecting point has been cut off, as shown by Fig. 3. Heel-Tap (9), broken to twenty-six feet, dredged to twenty-two feet, to be cleaned to full depth. Great Mill Rock (10), Little Mill Rock (11), connected by a dike; nothing further to be done here. The Gridiron (12), Flood Rock (13), Hen and Chickens (14), Negro Heads (15), broken to thirty feet; 15 is now being removed to open the Middle Channel at once, and the balance afterward to full depth. Rylander's Reef (16) to be embanked. Bread and Cheese (17) has already been embanked. Scaly Rock (18) has been removed.

It will be readily understood from the above description what has been contemplated by these improvements, how far they have already been carried out and what purpose they have served, and how adequate will be the channel after they are completed.

THE INTERPRETERS OF GENESIS AND THE INTERPRETERS OF NATURE.

By Professor T. H. HUXLEY.

OUR fabulist warns "those who in quarrels interpose" of the fate which is probably in store for them; and, in venturing to place myself between so powerful a controversialist as Mr. Gladstone and the eminent divine whom he assaults with such vigor in the last number of this review, I am fully aware that I run great danger of verifying Gay's prediction. Moreover, it is quite possible that my zeal in offering aid to a combatant so extremely well able to take care of himself as M. Réville may be thought to savor of indiscretion.

Two considerations, however, have led me to face the double risk. The one is that though, in my judgment, M. Réville is wholly in the right in that part of the controversy to which I propose to restrict my observations, nevertheless, he, as a foreigner, has very little chance of making the truth prevail with Englishmen against the authority and the dialectic skill of the greatest master of persuasive rhetoric among English-speaking men of our time. As the Queen's proctor intervenes, in certain cases, between two litigants in the interests of justice, so it may be permitted me to interpose as a sort of uncommissioned science proctor. My second excuse for my meddlesomeness is, that important questions of natural science—respecting which neither of the combatants professes to speak as an expert—are involved in the controversy; and I think it is desirable that the public should know what it is that natural science really has to say on these topics, to the best belief of one who has been a diligent student of natural science for the last forty years.

The original "Prolégomènes de l'histoire des Religions" has not come in my way; but I have read the translation of M. Réville's work, published in England under the auspices of Professor Max Müller, with very great interest. It puts more fairly and clearly than any book previously known to me the view which a man of strong religious feelings, but at the same time possessing the information and the reasoning power which enable him to estimate the strength of scientific methods of inquiry and the weight of scientific truth, may be expected to take of the relation between science and religion.

In the chapter on "The Primitive Revelation" the scientific worth of the account of the Creation given in the Book of Genesis is estimated in terms which are as unquestionably respectful as, in my judgment, they are just; and, at the end of the chapter on "Primitive Tradition," M. Réville appraises the value of pentateuchal anthropology in a way which I should have thought sure of enlisting the assent of all competent judges, even if it were extended to the whole of the cosmogony and biology of Genesis:

> As, however, the original traditions of nations sprang up in an epoch less remote than our own from the primitive life, it is indispensable to consult them, to compare them, and to associate them with other sources of information which are available. From this point of view, the traditions recorded in Genesis possess, in addition to their own peculiar charm, a value of the highest order; but we can not ultimately see in them more than a venerable fragment, well deserving attention, of the great genesis of mankind.

Mr. Gladstone is of a different mind. He dissents from M. Réville's views respecting the proper estimation of the pentateuchal traditions no less than he does from his interpretation of those Homeric myths which have been the object of his own special study. In the latter case, Mr. Gladstone tells M. Réville that he is wrong on his own authority, to which, in such a matter, all will pay due respect: in the former, he affirms himself to be "wholly destitute of that kind of knowledge which carries authority," and his rebuke is administered in the name and by the authority of natural science.

An air of magisterial gravity hangs about the following passage:

> But the question is not here of a lofty poem, or a skillfully constructed narrative: it is whether natural science, in the patient exercise of its high calling to examine facts, finds that the works of God cry out against what we have fondly believed to be his word and tell another tale; or whether, in this nineteenth century of Christian progress, it substantially echoes back the majestic sound, which, before it existed as a pursuit, went forth into all lands.
>
> First, looking largely at the latter portion of the narrative, which describes the creation of living organisms, and waiving details, on some of which (as in verse 24) the Septuagint seems to vary from the Hebrew, there is a grand fourfold division, set forth in an orderly succession of times, as follows: on the fifth day—
>
> 1. The water-population;
> 2. The air-population;
>
> and, on the sixth day,
>
> 3. The land-population of animals;
> 4. The land-population consummated in man.
>
> Now this same fourfold order is understood to have been so affirmed in our time by natural science, that it may be taken as a demonstrated conclusion and established fact (p. 696).

"Understood"! By whom? I can not bring myself to imagine that Mr. Gladstone has made so solemn and authoritative a statement on a matter of this importance without due inquiry—without being able to found himself upon recognized scientific authority. But I wish he had thought fit to name the source from which he has derived his information, as, in that case, I could have dealt with his authority, and I should have thereby escaped the appearance of making an attack on Mr. Gladstone himself, which is in every way distasteful to me.

For I can meet the statement in the last paragraph of the above citation with nothing but a direct negative. If I know anything at all about the results attained by the natural science of our time, it is "a demonstrated conclusion and established fact" that the "fourfold order" given by Mr. Gladstone is not that in which the evidence at our disposal tends to show that the water, air, and land populations of the globe have made their appearance.

Perhaps I may be told that Mr. Gladstone does give his authority—that he cites Cuvier, Sir John Herschel, and Dr. Whewell in support of his case. If that has been Mr. Gladstone's intention in mentioning these eminent names, I may remark that, on this particular question, the only relevant authority is that of Cuvier. But, great as Cuvier was, it is to be remembered that, as Mr. Gladstone incidentally remarks, he can not now be called a recent authority. In fact, he has been dead more than half a century, and the paleontology of our day is related to that of his very much as the geography of the sixteenth century is related to that of the fourteenth. Since 1832, when Cuvier died, not only a new world, but new worlds, of ancient life have been discovered; and those who have most faithfully carried on the work of the chief founder of paleontology have done most to invalidate the essentially negative grounds of his speculative adherence to tradition.

If Mr. Gladstone's latest information on these matters is derived from the famous discourse prefixed to the "Ossemens Fossiles," I can understand the position he has taken up; if he has ever opened a respectable modern manual of paleontology or geology, I can not. For the facts which demolish his whole argument are of the commonest notoriety. But, before proceeding to consider the evidence for this assertion, we must be clear about the meaning of the phraseology employed.

I apprehend that when Mr. Gladstone uses the term "water-population" he means those animals which, in Genesis i, 21 (revised version), are spoken of as "the great sea-monsters and every living creature that moveth, which the waters brought forth abundantly, after their kind." And I presume that it will be agreed that whales and porpoises, sea-fishes, and the innumerable hosts of marine invertebrated animals, are meant thereby. So "air-population" must be the equivalent of "fowl," in verse 20, and "every winged fowl after its kind," verse 21. I suppose I may take it for granted that by "fowl" we have here to understand birds—at any rate primarily. Secondarily, it may be that the bats, and the extinct pterodactyls, which were flying reptiles, come under the same head. But, whether all insects are "creeping things" of the land-population, or whether flying insects are to be included under the denomination of "winged fowl," is a point for the decision of Hebrew exegetes. Lastly, I suppose I may assume that "land-population" signifies "the cattle" and "the beast of the earth," and "every creeping thing that creepeth upon the earth," in verses 25 and 26; presumably, it comprehends all kinds of terrestrial animals, vertebrate and invertebrate, except such as may be comprised under the head of the "air-population."

Now what I want to make clear is this: that if the terms "water-population," "air-population," and "land-population," are understood in the senses here defined, natural science has nothing to say in favor of the proposition that they succeeded one another in the order given by Mr. Gladstone; but that, on the contrary, all the evidence we possess goes to prove that they did not. Whence it will follow that, if Mr. Gladstone has interpreted Genesis rightly (on which point I am most anxious to be understood to offer no opinion), that interpretation is wholly irreconcilable with the conclusions at present accepted by the interpreters of Nature—with everything that can be called "a demonstrated conclusion and established fact" of natural science. And be it observed that I am not here dealing with a question of speculation, but with a question of fact.

Either the geological record is sufficiently complete to afford us a means of determining the order in which animals have made their appearance on the globe, or it is not. If it is, the determination of that order is little more than a mere matter of observation; if it is not, then natural science neither affirms nor refutes the "fourfold order," but is simply silent.

The series of the fossiliferous deposits, which contain the remains of the animals which have lived on the earth in past ages of its history, and which can alone afford the evidence required by natural science of the order of appearance of their different species, may be grouped in the manner shown in the left-hand column of the following table, the oldest being at the bottom:

Formations.	First known appearance of
Quaternary.	
Pliocene.	
Miocene.	
Eocene	Vertebrate *air*-population (bats).
Cretaceous.	
Jurassic	Vertebrate *air*-population (birds and pterodactyls).
Triassic.	
Upper Palæozoic.	
Middle Palæozoic	Vertebrate *land*-population (amphibia, reptilia [?]).
Lower Palæozoic.	
Silurian	Vertebrate *water*-population (fishes).
	Invertebrate *air*- and *land*-population (flying insects and scorpions).
Cambrian	Invertebrate *water*-population (much earlier, if *Eozoön* is animal).

In the right-hand column I have noted the group of strata in which, according to our present information, the *land*, *air*, and *water* populations respectively appear for the first time; and, in consequence of the ambiguity about the meaning of "fowl," I have separately indicated the first appearance of bats, birds, flying reptiles, and flying insects. It will be observed that, if "fowl" means only "bird," or at most flying vertebrate, then the first certain evidence of the latter, in the Jurassic epoch, is posterior to the first appearance of truly terrestrial *Amphibia*, and possibly of true reptiles, in the Carboniferous epoch (Middle Palæozoic) by a prodigious interval of time.

The water-population of vertebrated animals first appears in the Upper Silurian. Therefore, if we found ourselves on vertebrated animals and take "fowl" to mean birds only, or, at most, flying vertebrates, natural science says that the order of succession was water, land, and air population, and not—as Mr. Gladstone, founding himself on Genesis, says—water, air, land population. If a chronicler of Greece affirmed that the age of Alexander preceded that of Pericles and immediately succeeded that of the Trojan War, Mr. Gladstone would hardly say that this order is "understood to have been so affirmed by historical science that it may be taken as a demonstrated conclusion and established fact." Yet natural science "affirms" his "fourfold order" to exactly the same extent—neither more nor less.

Suppose, however, that "fowl" is to be taken to include flying insects. In that case, the first appearance of an air-population must be shifted back for long ages, recent discovery having shown that they occur in rocks of Silurian age. Hence, there might still have been hope for the fourfold order, were it not that the Fates unkindly determined that scorpions—"creeping things that creep on the earth" *par excellence*—turned up in Silurian strata, nearly at the same time. So that, if the word in the original Hebrew translated "fowl" should really, after all, mean "cockroach"—and I have great faith in the elasticity of that tongue in the hands of biblical exegetes—the order primarily suggested by the existing evidence—

2. Land and air population,
1. Water-population,

and Mr. Gladstone's order—

3. Land-population,
2. Air-population,
1. Water-population,

can by no means be made to coincide. As a matter of fact, then, the statement so confidently put forward turns out to be devoid of foundation and in direct contradiction of the evidence at present at our disposal.*

* It may be objected that I have not put the case fairly, inasmuch as the solitary insect's wing which was discovered twelve months ago in Silurian rocks, and which is, at present, the sole evidence of insects older than the Devonian epoch, came from strata of Middle Silurian age, and is therefore older than the scorpions which, within the last two years, have been found in Upper Silurian strata in Sweden, Britain, and the United States. But no one who comprehends the nature of the evidence afforded by fossil remains would venture to say that the non-discovery of scorpions in the Middle Silurian strata, up to this time, affords any more ground for supposing that they did not exist, than the non-discovery of flying insects in the Upper Silurian strata, up to this time, throws any doubt on

If, stepping beyond that which may be learned from the facts of the successive appearance of the forms of animal life upon the surface of the globe, in so far as they are yet made known to us by natural science, we apply our reasoning faculties to the task of finding out what those observed facts mean, the present conclusions of the interpreters of Nature appear to be no less directly in conflict with those of the latest interpreter of Genesis.

Mr. Gladstone appears to admit that there is some truth in the doctrine of evolution, and indeed places it under very high patronage:

> I contend that evolution in its highest form has not been a thing heretofore unknown to history, to philosophy, or to theology. I contend that it was before the mind of Saint Paul when he taught that in the fullness of time God sent forth his Son, and of Eusebius, when he wrote the "Preparation for the Gospel," and of Augustine when he composed the "City of God" (p. 706).

Has any one ever disputed the contention thus solemnly enunciated that the doctrine of evolution was not invented the day before yesterday? Has any one ever dreamed of claiming it as a modern innovation? Is there any one so ignorant of the history of philosophy as to be unaware that it is one of the forms in which speculation embodied itself long before the time either of the Bishop of Hippo or of the Apostle to the Gentiles? Is Mr. Gladstone, of all people in the world, disposed to ignore the founders of Greek philosophy, to say nothing of Indian sages, to whom evolution was a familiar notion ages before Paul of Tarsus was born? But it is ungrateful to cavil at even the most oblique admission of the possible value of one of those affirmations of natural science which really may be said to be "a demonstrated conclusion and established fact." I note it with pleasure, if only for the purpose of introducing the observation that, if there is any truth whatever in the doctrine of evolution as applied to animals, Mr. Gladstone's gloss on Genesis in the following passage is hardly happy:

> God created—
> (*a*) The water-population;
> (*b*) The air-population.
> And they receive his benediction (verses 20–23).
> 6. Pursuing this regular progression from the lower to the higher, from the simple to the complex, the text now gives us the work of the sixth "day," which supplies the land-population, air and water having been already supplied (pp. 695, 696).

The gloss to which I refer is the assumption that the "air-population" forms a term in the order of progression from lower to higher, from simple to complex—the place of which lies between the water-population below and the land-population above—and I speak of it

the certainty that they existed, which is derived from the occurrence of the wing in the Middle Silurian. In fact, I have stretched a point in admitting that these fossils afford a colorable pretext for the assumption that the land and air population were of contemporaneous origin.

as a "gloss," because the pentateuchal writer is nowise responsible for it.

But it is not true that the air-population, as a whole, is "lower" or less "complex" than the land-population. On the contrary, every beginner in the study of animal morphology is aware that the organization of a bat, of a bird, or of a pterodactyl, presupposes that of a terrestrial quadruped; and that it is intelligible only as an extreme modification of the organization of a terrestrial mammal or reptile. In the same way, winged insects (if they are to be counted among the "air-population") presuppose insects which were wingless, and therefore, as "creeping things," were part of the land-population. Thus theory is as much opposed as observation to the admission that natural science indorses the succession of animal life which Mr. Gladstone finds in Genesis. On the contrary, a good many representatives of natural science would be prepared to say, on theoretical grounds alone, that it is incredible that the "air-population" should have appeared before the "land-population"—and that, if this assertion is to be found in Genesis, it merely demonstrates the scientific worthlessness of the story of which it forms a part.

Indeed, we may go further. It is not even admissible to say that the water-population, as a whole, appeared before the air and the land populations. According to the Authorized Version, Genesis especially mentions among the animals created on the fifth day "great whales," in place of which the Revised Version reads "great sea monsters." Far be it from me to give an opinion which rendering is right, or whether either is right. All I desire to remark is, that if whales and porpoises, dugongs and manatees, are to be regarded as members of the water-population (and if they are not, what animals can claim the designation?), then that much of the water-population has as certainly originated later than the land-population as bats and birds have. For I am not aware that any competent judge would hesitate to admit that the organization of these animals shows the most obvious signs of their descent from terrestrial quadrupeds.

A similar criticism applies to Mr. Gladstone's assumption that, as the fourth act of that "orderly succession of times" enunciated in Genesis, "the land-population consummated in man."

If this means simply that man is the final term in the evolutional series of which he forms a part, I do not suppose that any objection will be raised to that statement on the part of students of natural science. But if the pentateuchal author goes further than this, and intends to say that which is ascribed to him by Mr. Gladstone, I think natural science will have to enter a *caveat*. It is not by any means certain that man—I mean the species *Homo sapiens* of zoölogical terminology—has "consummated" the land-population in the sense of appearing at a later period of time than any other. Let me make my meaning clear by an example. From a morphological point of view, our beautiful and useful contemporary—I might almost call him colleague—the Horse (*Equus caballus*), is the last term of the evolutional series to which he belongs, just as *Homo sapiens* is the last term of the series of which he is a member. If I want to know whether the species *Equus caballus* made its appearance on the surface of the globe before or after *Homo sapiens*, deduction from known laws does not help me. There is no reason that I know of why one should have appeared sooner or later than the other. If I turn to observation, I find abundant remains of *Equus caballus* in Quaternary strata, perhaps a little earlier. The existence of *Homo sapiens* in the Quaternary epoch is also certain. Evidence has been adduced in favor of man's existence in the Pliocene or even in the Miocene epoch. It does not satisfy me; but I have no reason to doubt that the fact may be so, nevertheless. Indeed, I think it is quite possible that further research will show that *Homo sapiens* existed, not only before *Equus caballus*, but before many other of the existing forms of animal life; so that, if all the species of animals have been separately created, man, in this case, would by no means be the "consummation" of the land-population.

I am raising no objection to the position of the fourth term in Mr. Gladstone's "order"—on the facts, as they stand, it is quite open to any one to hold, as a pious opinion, that the fabrication of man was the acme and final achievement of the process of peopling the globe. But it must not be said that natural science counts this opinion among her "demonstrated conclusions and established facts," for there would be just as much, or as little, reason for ranging the contrary opinion among them.

It may seem superfluous to add to the evidence that Mr. Gladstone has been utterly misled in supposing that his interpretation of Genesis receives any support from natural science. But it is as well to do one's work thoroughly while one is about it; and I think it may be advisable to point out that the facts, as they are at present known, not only refute Mr. Gladstone's interpretation of Genesis in detail, but are opposed to the central idea on which it appears to be based.

There must be some position from which the reconcilers of science and Genesis will not retreat, some central idea the maintenance of which is vital and its refutation fatal. Even if they now allow that the words "the evening and the morning" have not the least reference to a natural day, but mean a period of any number of millions of years that may be necessary; even if they are driven to admit that the word "creation," which so many millions of pious Jews and Christians have held, and still hold, to mean a sudden act of the Deity, signifies a process of gradual evolution of one species from another, extending through immeasurable time; even if they are willing to grant that the asserted coincidence of the order of Nature with the "fourfold order" ascribed to Genesis is an obvious error instead of an established truth—they are surely prepared to make a last stand upon the conception which underlies the whole, and which constitutes the essence of Mr. Gladstone's "fourfold division, set forth in an orderly succession of times." It is, that the animal species which compose the water-population, the air-population, and the land-population respectively, originated during three distinct and successive periods of time, and only during those periods of time.

This statement appears to me to be the interpretation of Genesis which Mr. Gladstone supports, reduced to its simplest expression. "Period of time" is substituted for "day"; "originated" is substituted for "created"; and any order required for that adopted by Mr. Gladstone. It is necessary to make this proviso, for if "day" may mean a few million years, and "creation" may mean evolution, then it is obvious that the order (1) water-population, (2) air-population, (3) land-population, may also mean (1) water-population, (2) land-population, (3) air-population; and it would be unkind to bind down the reconcilers to this detail when one has parted with so many others to oblige them.

But even this sublimated essence of the pentateuchal doctrine (if it be such) remains as discordant with natural science as ever.

It is not true that the species composing any one of the three populations originated during any one of three successive periods of time, and not at any other of these.

Undoubtedly, it is in the highest degree probable that animal life appeared first under aquatic conditions; that terrestrial forms appeared later, and flying animals only after land animals; but it is, at the same time, testified by all the evidence we possess, that the great majority, if not the whole, of the primordial species of each division have long since died out, and have been replaced by a vast succession of new forms. Hundreds of thousands of animal species, as distinct as those which now compose our water, land, and air populations, have come into existence and died out again, throughout the æons of geological time which separate us from the lower Palæozoic epoch, when, as I have pointed out, our present evidence of the existence of such distinct populations commences. If the species of animals have all been separately created, then it follows that hundreds of thousands of acts of creative energy have occurred at intervals throughout the whole time recorded by the fossiliferous rocks; and, during the greater part of that time, the "creation" of the members of the water, land, and air populations must have gone on contemporaneously.

If we represent the water, land, and air populations by a, b, and c respectively, and take vertical succession on the page to indicate order in time, then the following schemes will roughly shadow forth the contrast I have been endeavoring to explain:

Genesis (as interpreted by Mr. Gladstone).	Nature (as interpreted by natural science).
$b\ b\ b$	$c^1\ a^3\ b^2$
$c\ c\ c$	$c\ a^2\ b^1$
$a\ a\ a$	$b\ a^1\ b$
	$a\ a\ a$

So far as I can see, there is only one resource left for those modern representatives of Sisyphus, the reconcilers of Genesis with science; and it has the advantage of being founded on a perfectly legitimate appeal to our ignorance. It has been seen that, on any interpretation of the terms water-population and land-population, it must be admitted that invertebrate representatives of these populations existed during the lower Palæozoic epoch. No evolutionist can hesitate to admit that other land-animals (and possibly vertebrates among them) may have existed during that time, of the history of which we know so little; and, further, that scorpions are animals of such high organization that it is highly probable their existence indicates that of a long antecedent land-population of a similar character.

Then, since the land-population is said not to have been created until the sixth day, it necessarily follows that the evidence of the order in which animals appeared must be sought in the record of those older Palæozoic times in which only traces of the water-population have as yet been discovered.

Therefore, if any one chooses to say that the creative work took place in the Cambrian or Laurentian epoch in exactly that manner which Mr. Gladstone does and natural science does not affirm, natural science is not in a position to disprove the accuracy of the statement. Only one can not have one's cake and eat it too, and such safety from the contradiction of Science means the forfeiture of her support.

Whether the account of the work of the first, second, and third days in Genesis would be confirmed by the demonstration of the truth of the nebular hypothesis; whether it is corroborated by what is known of the nature and probable relative antiquity of the heavenly bodies; whether, if the Hebrew word translated "firmament" in the Authorized Version really means "expanse," the assertion that the waters are partly under this "expanse" and partly above it would be any more confirmed by the ascertained facts of physical geography and meteorology than it was before; whether the creation of the whole vegetable world, and especially of "grass, herb yielding seed after its kind, and tree bearing fruit," before any kind of animal is "affirmed" by the apparently plain teaching of botanical paleontology, that grasses and fruit-trees originated long subsequently to animals—all these are questions which, if I mistake not, would be answered decisively in the negative by those who are specially conversant with the sciences involved. And it must be recollected that the issue raised by Mr. Gladstone is not whether, by some effort of ingenuity, the pentateuchal story can be shown to be not disprovable by scientific knowledge, but whether it is supported thereby.

There is nothing, then, in the criticisms of Dr. Réville but what rather tends to confirm than to impair the old-fashioned belief that there is a revelation in the Book of Genesis (p. 694).

The form into which Mr. Gladstone has thought fit to throw this opinion leaves me in doubt as to its substance. I do not understand how a hostile criticism can, under any circumstances, tend to confirm that which it attacks. If, however, Mr. Gladstone merely means to express his personal impression, "as one wholly destitute of that kind of knowledge which carries authority," that he has destroyed the value of these criticisms, I have neither the wish nor the right to attempt to disturb his faith. On the other hand, I may be permitted to state my own conviction that, so far as natural science is involved, M. Réville's observations retain the exact value they possessed before Mr. Gladstone attacked them.

Trusting that I have now said enough to secure the author of a wise and moderate disquisition upon a topic which seems fated to stir unwisdom and fanaticism to their depths, a fuller measure of justice than has hitherto been accorded to him, I retire from my self-appointed championship, with the hope that I shall not hereafter be called upon by M. Réville to apologize for damage done to his strong case by imperfect or impulsive advocacy. But perhaps I may be permitted to add a word or two, on my own account, in reference to the great question of the relations between science and religion, since it is one about which I have thought a good deal ever since I have been able to think at all, and about which I have ventured to express my views publicly, more than once, in the course of the last thirty years.

The antagonism between science and religion, about which we hear so much, appears to me to be purely factitious—fabricated, on the one hand, by short-sighted religious people who confound a certain branch of science, theology, with religion; and, on the other, by equally short-sighted scientific people who forget that science takes for its province only that which is susceptible of clear intellectual comprehension, and that outside the boundaries of that province they must be content with imagination, with hope, and with ignorance.

It seems to me that the moral and intellectual life of the civilized nations of Europe is the product of that interaction, sometimes in the way of antagonism, sometimes in that of profitable interchange, of the Semitic and the Aryan races, which commenced with the dawn of history, when Greek and Phœnician came in contact, and has been continued by Carthaginian and Roman, by Jew and Gentile, down to the present day. Our art (except, perhaps, music) and our science are the contributions of the Aryan; but the essence of our religion is derived from the Semite. In the eighth century B. C., in the heart of a world of idolatrous polytheists, the Hebrew prophets put forth a conception of religion which appears to me to be as wonderful an inspiration of genius as the art of Pheidias or the science of Aristotle.

"And what doth the Lord require of thee, but to do justly, and to love mercy, and to walk humbly with thy God?"

If any so-called religion takes away from this great saying of Micah, I think it wantonly mutilates, while, if it adds thereto, I think it obscures, the perfect ideal of religion.

But what extent of knowledge, what acuteness of scientific criticism, can touch this, if any one possessed of knowledge or acuteness could be absurd enough to make the attempt? Will the progress of research prove that justice is worthless, and mercy hateful; will it ever soften the bitter contrast between our actions and our aspirations; or show us the bounds of the universe, and bid us say, Go to, now we comprehend the infinite?

A faculty of wrath lay in those ancient Israelites, and surely the prophet's staff would have made swift acquaintance with the head of the scholar who had asked Micah whether, peradventure, the Lord further required of him an implicit belief in the accuracy of the cosmogony of Genesis!

What we are usually pleased to call religion nowadays is, for the most part, Hellenized Judaism; and, not unfrequently, the Hellenic element carries with it a mighty remnant of old-world paganism and a great infusion of the worst and weakest products of Greek scientific speculation; while fragments of Persian and Babylonian, or rather Accadian, mythology burden the Judaic contribution to the common stock.

The antagonism of science is not to religion, but to the heathen survivals and the bad philosophy under which religion herself is often well-nigh crushed. And, for my part, I trust that this antagonism will never cease; but that, to the end of time, true Science will continue to fulfill one of her most beneficent functions, that of relieving men from the burden of false science which is imposed upon them in the name of religion.

This is the work that M. Réville and men such as he are doing for us; this is the work which his opponents are endeavoring, consciously or unconsciously, to hinder.—*Nineteenth Century.*

RECENT EXPERIMENTS IN STATE TAXATION.

By HENRY JAMES TEN EYCK.

TO growl is the privilege of the tax-payer. To secure the entire amount of the necessary revenue with the smallest growl is the aim of the legislator. Probably there is no more unpopular official than the tax-gatherer. Among persons of property the idea seems to prevail that taxation is a kind of robbery which is to be evaded if possible. It is true that the public treasury has often been filled simply that thieves might plunder it, or that worthless citizens might be supported at public expense, as a reward for their political work. This is the case particularly in the administration of municipal affairs. The national and State governments have been conducted, in spite of the observance of the odious spoils system, with an efficiency and economy unequaled by but few great business houses. Even better service would undoubtedly be obtained if the public had a fuller appreciation of the truth of the old paradox that the dearest labor is the cheapest. More liberal salaries for positions of trust and executive control would tend to elevate decidedly the standard and ability of the men in the public service. But, unfortunately, propositions of this character do not meet with general approval. The vulnerable spot of the American is his pocket-book. When an official lays his hands on that, the victim resents the attack with indignation, and submits, after loud protestations and threats, to the demand for his money, only out of respect for the superior power of the law. The dominant party, in attempting to carry on the government satisfactorily, and, at the same time, not arouse the voter who pays the taxes, has a difficult problem to solve. In the United States, where the voter is the ruler, political managers find it essential to continued success to make the drafts on the ruler's pocket-book as light as possible. All parties would be happy if the public treasury could be filled by the touch of a magician's wand, so that taxes might be abolished. But, as they are a necessary evil, a scheme of taxation without lamentation is what is wanted. In the law laid down by Professor William G. Sumner, that taxation tends to diffuse itself, but on the line of least resistance, is found a hint for the basis of this scheme. Turgot, the great French financier, expressed the politician's idea very tersely when he said that the science of taxation is to pluck the goose without making it cry. In hunting for the line of least resistance, and the most scientific methods of plucking, several interesting experiments have been made of late in different States, where new sources of revenue have been sought from special taxes on corporations, railroads, telegraph, telephone, and insurance companies, collateral inheritances, and other classes of property which can be plucked without producing a cry liable to strike a chord of sympathy in the popular heart. In most instances these experiments have surpassed in their results the expectations of the proposers. Large revenue has been obtained without provoking even a murmur of disapproval from the voting classes. In Vermont, for example, no direct tax was levied in 1883 and 1884, the receipts under the corporation tax law paying the expenses of the State government. The Comptroller of New York received $9,569,-161.35 in 1884, of which $1,603,612.75 were paid by corporations. Last year,* although the Wisconsin Legislature authorized a levy of $240,000, the State Treasurer was not obliged to collect any direct tax, as the license-tax from railroads, insurance, telegraph, and telephone companies was sufficient to meet the current expenses. The Treasurer

* 1884. The article was written June, 1885.

of Minnesota states that "the revenue from the corporation tax is steadily increasing, and if it should continue to increase, and the probabilities are that it will, as it has done for the last four years, it bids fair to pay all the expenses of the State government." In New Jersey there is no regular tax, except for schools, as the new railroad and canal tax law and the tax on miscellaneous corporations maintain the government.

These are striking illustrations of the workings of a new system of imposing special taxes on special classes of property, which was only first tried about ten years ago. The idea of treating railroads and corporations generally in a different manner in the tax levies from other kinds of property was a development, perhaps, of the granger and anti-monopoly movements. It is founded on the theory that parties enjoying special privileges from the State should share with the State, to some extent, the profits of their enterprises. If the Government gives certain individuals peculiar advantages and protection in the inauguration and prosecution of their schemes and business, it is held that they should make a return for the favors granted, in proportion to the success of their undertaking. In every State where the plan has been tried it has worked admirably. After a stout resistance on the part of the corporations, resulting in a judicial interpretation of all the provisions of the statute, the execution of the new law goes on smoothly in each State. The largest corporations naturally fight every encroachment on their sources of income, but when the law is once in full operation they submit gracefully. The various Legislatures adopting the system have endeavored not to make the tax too heavy. If the rate is moderate it inflicts no serious burden on the corporations, and yet brings a handsome sum into the public treasury. The benefits of this new plan have, so far, been appreciated only in the New England, Middle, and Northwestern States. Twelve States now impose special taxes on railroads and other corporations. In eight more, including three Southern States, insurance companies are subject to a special rate. The ordinary method of levying a direct tax on real and personal property still furnishes, in the large majority of States, almost the entire revenue. The old poll-tax remains a favorite form of taxation in parts of New England and the South, twelve States raising most of their school funds in that way. An examination of the tax laws of each of the thirty-eight Commonwealths indicates, however, a steady development of the idea of "taxation without lamentation." The attack is not confined to corporations. There is a reaching out in every direction for special subjects for taxation. If one State finds an object that can pay special rates without suffering materially, and without raising a popular outcry, other States follow in the line of the discovery. On the other hand, a number of experiments have been abandoned, after a year or two of trial, because the law was unconstitutional or unpopular. All the New England States have a tax on deposits in savings-banks. Maryland, Virginia, and Pennsylvania tax collateral inheritances. In New Hampshire the courts recently declared a law of this kind unconstitutional. Nine States derive part of their revenue from a tax on the liquor-traffic. Eight secure a considerable amount from licenses granted to trades and occupations by the State, instead of by the local authorities, as is the custom in most sections. A few of the oddities of taxation by States may be referred to here. Maryland last year obtained $110,050 from a tax on the commissions of executors and administrators of estates, one tenth part of the sum allowed them by the Orphans' Court being demanded by the State. North Carolina derived $63,000, in 1884, from a license of $100 on drummers. The declaration of the Ohio Supreme Court, last autumn, that the Scott liquor law was unconstitutional, has deprived the State of an annual revenue of over $50,000, and the cities within its borders of half a million. Pennsylvania and Virginia have income-taxes. Georgia gets $300,000 per annum as the rental of the Atlanta and West Point Railroad, and Illinois has seven percentum of the gross earnings of the Illinois Central Railroad, between $350,000 and $400,000 a year, as a charter tax. In South Carolina seventeen companies paid a royalty, for the use of the phosphate-beds, of $154,318, which is about one quarter of the amount raised for State purposes. The occupation-tax in Texas covers a very extensive list of trades and occupations. The total receipts of the treasury in 1884 were $1,539,918, and of this sum the occupation-taxes furnished $774,756. In Massachusetts there is a law for the taxation of corporations. The levy is made by the State; but the amount paid in is redistributed by the State to the cities and towns where the stockholders reside, and only so much thereof as is from non-residents remains in the State Treasury. Pennsylvania, by some strange process of reasoning, thinks that a man who owns a watch should pay a tax for the privilege. As only 45,596 watches are reported by a population of 4,500,000, the inference is, that the Quakers either conceal their time-pieces in an inner pocket, or regulate their lives by the town-clock or the sun.

A glance at the laws of a few States which have secured the most notable results in the direction of special taxation will show the scope and bearing of the movement. Pennsylvania may, perhaps, be called the pioneer. It has tried more experiments and probably reaches more special classes than any other State. The tax on the capital stock of all corporations, which yielded to the State $1,535,727.56 in 1884, is one half mill for each one per centum of dividend declared, provided the annual dividend amounts to six per centum or more. If the dividends are less than six per centum, or if there are no dividends, the tax is three mills upon each dollar of the appraised valuation, or market value, of the stock. A further tax of eight tenths of one per centum is imposed on the gross earnings of transportation and telegraph companies. This brought in last year $787,929.20. Insurance companies are assessed eight tenths of one per centum on gross premiums, and bank-stocks, mortgages, and loans of different kinds pay four per centum on every dollar of the value thereof. These special classes paid $954,843.59 in 1884. Collateral inheritances of over $200 are taxed three mills on every dollar. From this source $461,465.48 were derived. Tavern-licenses amounted to $426,429.19, and retailers' licenses to $301,393.42. Nothing illustrates better how effectively this system of special taxation can be applied than the fact that while the total receipts of the Pennsylvania State Treasury in 1884 were $6,226,959.38, only $502,025.43 were raised by a direct general tax. New York State, which is first in wealth and the amount of revenue collected, has not pushed the system to such an extent, although it is rapidly following in the course of its neighbor. The tax on the capital stock of corporations is only one half of that levied in Pennsylvania, namely, one quarter of a mill for each one per centum of dividends if the dividends equal or exceed six per centum, and one and one half mill upon each dollar of a valuation of the capital stock when they are under six per centum or *nil*. The tax on the gross earnings of transportation, navigation, telegraph, and telephone companies is one half per centum. This yielded in 1884 $1,603,612.75, insurance companies paying on their capital and premiums $241,676.15 of the amount. In Wisconsin, where special taxes have also worked well, the plan is somewhat different. The license-tax, as it is called there, applies to railroads, insurance, telegraph, and telephone companies. Railroads are taxed from five dollars per mile of operated road to four per centum of gross earnings, as follows: If the road earns less than $1,500 per mile, it is taxed five dollars per mile; on those earning more than $1,500 and less than $3,000 per mile, the tax is five dollars per mile, and two per centum on the excess over $1,500 per mile; on those earning $3,000 or more per mile, the tax is four per centum on gross earnings. Telegraph companies pay one dollar per mile for the first wire, fifty cents per mile for the second, twenty-five cents per mile for the third, and twenty cents per mile for the fourth and all additional. Telephone companies pay one per centum on gross receipts, and insurance companies two per centum on gross earnings. This tax or license is in lieu of all other taxes, and amounted in 1884 to: Railroads, $754,269.44; telegraph, $4,568.85; telephone, $1,169.26; insurance, $64,904.75; or a total of $824,912.30. Vermont, which pays nearly its entire expenses out of the special taxes, has a law somewhat similar to that of Wisconsin. It levies two per centum on railroads on the first $2,000 of earnings per mile. The rate increases one per centum for each additional $1,000 per mile up to $5,000, and on all earnings over $5,000 per mile it is five per centum. Insurance companies pay two per centum on gross premiums, and life-insurance companies in addition one per centum on all surplus over the necessary reserve computed at four per centum on existing policies. Savings-banks pay one half per centum on deposits; express, telegraph, and telephone companies, three per centum on gross earnings, and steamboats two per centum. These quotations are sufficient to show the methods of corporation taxation.

The expediency and justice of a tax on collateral inheritances is not so readily admitted. Although it has been enforced as a war-tax, it is somewhat of an innovation on the principles of taxation observed in this country. There is a slight flavor of communism in the idea, yet the proposition is not altogether objectionable, and may be sustained by good arguments. A law of a similar character has been in operation in England many years. It is held to be in the nature of a franchise or license tax, upon the right derived from the state of transmitting property, and is inflicted only when property is bequeathed out of the immediate family. If there are no constitutional objections, the recipients of the bequests certainly have no cause for complaint, if the Government compels them to pay a small share of their gift for its support. A Pennsylvania man, for instance, who receives a windfall of $100,000 from a distant relative or an intimate friend, will obtain no sympathy if he growls because he is obliged to turn over $3,000 of it into the public treasury. He is better able to do so than any other man who has acquired his property by hard toil and individual exertion and enterprise. In Maryland the rate is two and one half per centum on every $100 of collateral inheritances over $500, and the tax yielded, last year, $86,218.46. The New York Legislature last winter passed a bill imposing a tax of five per centum on similar bequests. Although it aroused some opposition, Governor Hill signed the measure, with a recommendation that it be amended next winter so as to place the limit at $5,000 instead of $500, it being argued that in its present form it might place heavy burdens on poor persons who might receive small bequests of $1,000 or $2,000. It is estimated that the new law will yield annually in New York between $750,000 and $1,000,000. Evidences of the spread of the idea of "taxation without lamentation" are found in the recent proceedings of the Legislatures of other States. In Pennsylvania a bill was introduced, in April last, imposing a tax of five mills on the interest of deposits in savings-banks having no capital stock. There are obvious reasons for not taxing deposits in savings-banks, and it is to be hoped that this sort of special taxation will not be more extensively adopted. Notwithstanding the disastrous results, politically, in other States, of a heavy tax on the liquor-traffic, Illinois has just placed on its statute-books a law imposing a tax of $500 per annum on the sale of liquors, and $150 per annum on the sale of beer. In California, at the last session, a bill was passed to submit to the people an amendment to the Constitution providing that railroads shall pay an annual tax of two and a half per centum on gross earnings, and also that income-taxes may be assessed and collected from persons and corporations. The existing laws, and these recent efforts to secure additional statutes for raising the State revenues by means of special taxation, mark the development of new methods of taxation based principally on the growth of corporate wealth and the prosperity of certain privileged and, in some cases, like the liquor-traffic, objectionable classes of industry and business. The proportion of the States in which they are on trial is as yet small. The number, however, is steadily increasing. As the advantages of the new plan are brought more clearly before the notice of legislators, we may expect a revolution in State taxation. So great has been the progress in the past ten years that it would not be astonishing to see at the end of the next decade fully one half of the States levying merely a nominal direct tax, or none at all. Special privileged classes will probably bear the burden of State taxation in the future. The tariff will furnish the national revenue, and the main tax on real and personal property will be for the necessities of county and municipal government. The only danger lies in a tendency to overdo the matter. The special taxes must not be oppressive. The rights of the special classes, as well as of the other tax-payers, must be protected. If co-operation between the States could be assured, so that uniform and equitable rates might be established, great benefit would be derived by all property-owners.

BISHOP'S RING AROUND THE SUN.

By WILLIAM M. DAVIS.

IF there is nothing new under the sun, there is at least something new around it. For the last two years close observers of the sky have noticed that the noonday sun has been surrounded by a corona of dusky, coppery, or reddish light, as it has been variously described, the circle of most distinct color having a radius of about fifteen degrees, and inclosing a brilliant, silvery or bluish glow close around the solar disk. A similar appearance of much less intensity has been occasionally noticed around the full moon on very clear winter nights.

The most experienced observers of sky-colors are agreed that this corona was not visible before the latter months of 1883. Von Bezold, of Munich, who was considered the most competent meteorologist to prepare a schedule for observations on the colors of the sky for the recent German Arctic Expedition, says that, in spite of the close attention he had previously given to the appearance of the usual whitish glow around the sun, he had never till recently seen the dusky ring. Thollon, of Nice, who had made a special study of the sky around the sun for a series of years, declares confidently that a change occurred in November, 1883. Backhouse, of Sunderland, who has a careful record of parhelia for twenty-five years, confirms this opinion. We may, therefore, safely accept the conclusion that the change of color from the blue of the open sky to the intense glare of whitish light close around the sun, was until lately effected without the appearance of any reddish tinge in the transitional area.

The new corona, to which the name of "Bishop's ring" has been given after its first observer, has never been a very conspicuous affair, and therefore has not attracted the popular attention that it deserves; but it could easily be seen every clear day last winter, and has repeatedly been noticed since then in the latter months of 1885. The hazy days of summer are not favorable to its visibility. It is best seen from elevated stations, which gain their sky-colors chiefly from the finer particles floating at great altitudes, as they are above the lower strata of the atmosphere where the relatively coarse, haze-making dust is suspended. Forel, of Morges, one of the most acute observers of terrestrial physics in Switzerland, reports the distinct visibility of the ring from mountain-tops, while it is not to be seen from the valleys, where the whitish, hazy light overpowers its delicate colors. He adds that many of his countrymen in the higher Alps had been struck with the appearance of the new color in the sky before they had heard mention of it. For the same reason Tissandier found the distinctness of the corona greatly increased when viewed from a balloon high above the dusty air of Paris. At low-level stations it is best seen during the persistence of that type of weather known as "anti-cyclonic" among modern meteorologists. Such weather is characterized by high barometric pressure, and consequently has descending currents of pure, clean upper air. The sky is then brilliantly clear and free from haze, and at such times last winter the ring was of remarkable distinctness. Thin cirrus clouds generally hide it; but the presence of scattered, sharp-edged cumulus clouds adds to its visibility in the clear spaces between them. Let one of them stand before the sun, so that its heavy shadow darkens the lower air, whose reflecting particles ordinarily add much white light to the blue of the sky; then, looking between the clouds in the neighborhood of the sun, a broad arc of the ring appears with its colors blending in what may be fairly called the most delicate intensity. Just before a moderate thunder-storm early last June, the ring was thus presented with most beautiful effect. It was seen in Cambridge with extraordinary distinctness on the afternoon of November 2, 1885, when the lower clouds of a heavy rainstorm rapidly broke away in the west, about two o'clock, leaving the sun well hidden behind a sheet of upper cloud and a space of open sky below it. The lower air was thus well shaded from direct sunlight, and the strength of the colors was most remarkable. There was first the margin of the glowing central area at the edge of the cloud, soon turning pale brassy yellow, and then strong reddish gold at about fifteen to twenty degrees from the sun; farther out yet was the delicate rosy or purplish-pink, and at last the pure blue of the sky. The colors were wonderfully vivid for the time of day, although, of course, not so brilliant as those of a well-developed sunset; but it unfortunately seems to have very generally passed unnoticed. Inquiry among my neighbors failed to discover any one who had seen it.

Numerous observations in many parts of Europe and this country leave little room for question that the corona is produced in the upper atmosphere, and that it was continuously present above the cloudy or dusty lower air over a large part if not over the whole of the earth throughout 1884 and 1885.

The explanation of the optical process by which such a corona may be produced offers no particular difficulty. It is a relatively simple effect of diffraction, an effect of the same nature as that seen in the colored rings surrounding a light looked at through a glass that is faintly frosted over, as may be noticed almost any cold winter evening when looking out of a window. A brief statement of the process may be made, following the explanation given by Kiessling, to whom the author is much indebted in the preparation of this article.

Let us first consider the action of a beam of parallel rays of monochromatic light—that is, of strictly one-colored light, whose waves all agree in their period of vibration—as it passes an excessively fine thread stretched at right angles to its path, and falls on a screen beyond. The waves will be turned aside from and bent around both sides of the thread, as if diverging there from new centers of radiation. This is diffraction. A gross figure of the process is here given (Fig. 1) on a plane at right angles to the thread, T H. The point A

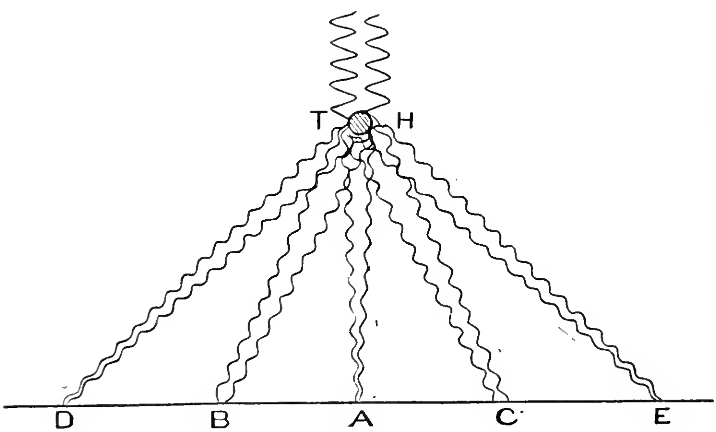


FIG. 1.

on the screen will be illuminated, although it is behind the thread, for the waves that reach A from either side of the thread agree in phase. Take a point, B or C, such that the distance B H exceeds B T by half a wave-length. Then the diffracted waves which agreed in phase at the thread will be just opposed at B, the crest of one will fall with the trough of the other; they are thus extinguished by interference, and darkness will result. Take another point, D, on the screen, such that D H differs from D T by a whole wave-length. Now the diffracted waves will agree in phase at D, and this point will be illuminated, like A. The screen will therefore be marked by a bright band behind the thread, and by dark and bright bands, blending together and parallel to it on either side. Their breadth will vary directly as the wave-length, and inversely as the diameter of the thread. The redder the ray and the finer the thread, the broader the bands.

Next consider the case of a single small particle of diameter greater than the wave-length in the path of the monochromatic beam. The same figure now may represent a plane parallel to the rays, passing through the particle in any direction. The parallel bands become concentric rings with a bright central spot behind the particle. The diameter of the rings varies, as above stated for the bands. The bluer the light and the larger the particle, the narrower the rings.

The next step makes an approach to the actual case by supposing a great number of one-sized particles floating in the space traversed by the waves, and considers their effect as perceived by an observer at A (Fig. 2). The unaltered light is seen in the direction of the rays

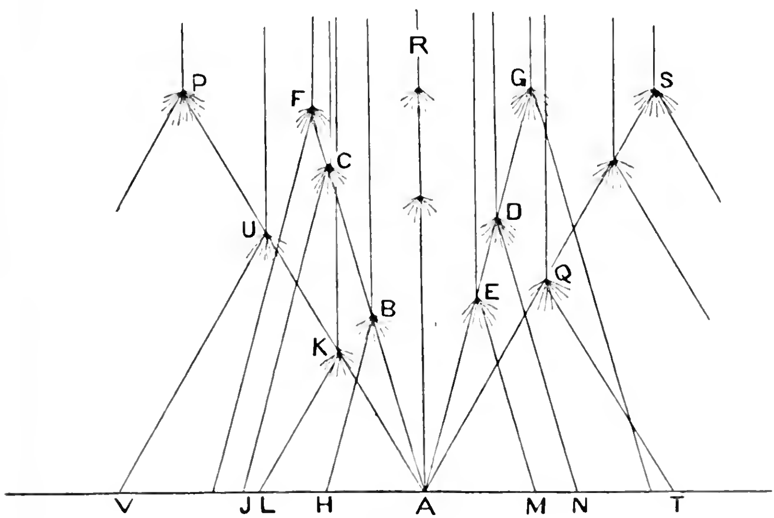


FIG. 2.

A R. Interference of the waves diffracted from B causes a dark circle on the surface V T, of diameter A H; from C, a circle A J; from D, a circle A N. Hence all the particles situated on the surface of a cone whose axis is A R, and apical angle is F A G, give no light to A, and the luminous center R seems to be surrounded by a dark ring at an angular distance R A F. This may be called a subjective ring in distinction from the objective rings, A H, A J, A N. In the same way, the particles situated on the cone P A S will contribute to the formation of a bright subjective ring of radial angle R A P. The center R will appear to be surrounded by dark and bright rings.

Now we must introduce the supposition of many-colored or polychromatic light—the white light of many wave-lengths that comes from the sun. Such light, passing a fine thread, forms a series of prismatic bands on a screen ; passing a single particle, it forms a series of concentric prismatic rings with the blue inside ; for the first blue ring will fall a little inside of the first yellow, and the first yellow inside of the first red—and so on with the others, until at a distance from the center the outer rings overlap irregularly. The subjective rings seen when white light passes through a transparent medium containing many one-sized particles will, for the same reason, appear many-colored, with the blue inside and the red outside ; the central area will be white, with a reddish margin.

Finally, the actual case is reached when the suspended particles are of different sizes. The colors of the central area now overlap so irregularly that they unite to form a whitish or silvery disk ; but the outer red margin of the central area formed by the smallest particles is still uncounterbalanced. The silvery disk will be reddish about the circumference ; and the colors thus deduced by theory are so closely like those observed in Bishop's ring around the sun that it may be safely considered a diffraction corona. The outer rings are too faint to be seen in daytime.

Colored coronal rings may be seen around a light when looking at it through a glass strewed lightly over with spores of lycopodium ; they are so nearly of the same size that a number of concentric rings appear. Kiessling describes some interesting experiments with thin artificial clouds of condensed vapors, through which the sun is seen surrounded with coronal rings. The moon is often surrounded with similar rings of small diameter, formed by diffraction, probably on small floating particles of ice, even when the sky seems clear. These are easily distinguished from halos. The latter are of definite and much larger diameter, and, when seen around the moon, are generally whitish ; if formed around the sun, they are visibly colored with the red *inside ;* and they are due to refraction and reflection on minute ice-crystals.

All this is safe enough ; it is the origin of the diffracting particles and the long endurance of their effect that give trouble. Indeed, the experimental and mathematical knowledge of optics, based on the undulatory theory of light, has advanced so far that the physicist is now better able to suggest processes by which effects may be produced than the meteorologist is able to apply them. The physicist can safely say that a sufficient supply of extremely fine liquid or solid dust scattered through the atmosphere would produce just such a solar corona as Bishop's ring. It is for the meteorologist to inquire whether a supply of dust sufficient in quantity and quality, appearing at the right time and enduring long enough, can be accounted for.

Kiessling, of Hamburg, already referred to, has done the best work on the corona as well as on the great sunsets with which it is evidently connected. His pamphlet, entitled "Die Dämmerungserscheinungen im Jahre 1883, und ihre physikalische Erklärung" (Hamburg, 1885), gives the most satisfactory account and explanation of the twilights that I have seen; and its value is largely increased by the experimental illustrations that the author has devised in imitation of the strange natural phenomena that he accounts for so well. A later paper, "Ueber die geographische Verbreitung des Bishop'schen Sonnenringes," in the May number of the little meteorological journal, "Das Wetter," and a short paper by Forel on "Le Cercle de Bishop," in the Geneva "Archives des Sciences" for June, are the most recent articles of consequence on the corona, and give important evidence as to the origin of its diffraction particles by showing its relation to the famous sunsets. The new corona was first noticed in Honolulu on the 5th of September, 1883, by the Rev. Sereno F. Bishop, who called attention to it by descriptions published at the time, and in letters to "Nature." Although seen so early in September in the Sandwich Islands, it was not recognized in this country till November 24th, when Professor Le Conte saw it at Berkeley, California; nor in Europe till the days directly following; but ever since then it has been continuously visible till now, in proper conditions of weather as already described. After rarely being seen in the summer, it has reappeared in the clearer days of the winter. Being always relatively inconspicuous, the date of its first visibility can not generally be determined with accuracy—alas for the neglect of so rare an opportunity of valuable observation!—but the agreement of the growth of the area in which it was noted and the spread of the great sunsets is placed beyond a doubt; and with them its origin must be referred to the explosive eruption of Krakatoa. Kiessling considers this relation of cause and effects to be firmly established, and even quotes approvingly the name given by Arcimis in Madrid, "corona solar krakatoense," although the name of "Bishop's ring" is undoubtedly the one that will come into general use.

The evident difficulties in the way of accepting the volcanic origin of the diffracting particles are the great quantity of material that would seem to be needed, the excessive fineness of its texture, and its long suspension in the thin upper air; but I believe that these difficulties are by no means fatal to the volcanic theory. The quantity needed is not absolutely so great, after all. Tyndall suggested that the minute, almost molecular particles, to which the blue color of the sky is usually referred, could all be contained in a snuff-box; and, while this need not be taken as in any way an accurate estimate of the mass of matter involved, it may nevertheless serve to measure the very low order of its quantity. Many snuff-boxfuls were thrown out of Krakatoa. Moreover, the dust-particles may be very sparsely scattered; the miles of air through which they are spread compensating for the wide space between them. The fineness of the solid dust is a legitimate result of what is now known of the constitution of lavas. Microscopic examination of igneous rocks has shown lithologists how well a volcanic explosion can produce diffracting dust; high magnifying power, applied to rocks that are presumably old buried lavas which failed to reach the surface, reveals the presence of the minutest cavities containing liquids or gases or both, so small and so closely packed that myriads would be contained in a cubic inch: under the decreasing pressures found as lavas rise through a vent to escape at the surface outlet, the occluded gases and vapors would escape, and in so doing would shatter the lavas to the finest imaginable dust. It is probably by this intimate process, as well as by ordinary forms of mechanical violence, that Krakatoa was, figuratively, blown to atoms. The greater and coarser part of the dust darkened the sky for a day or two and soon fell on the surrounding lands and seas; a finer remnant was carried high into the air by the outrushing gases, and then spread far and wide over the earth to produce the marvelous sunsets; does the finest residue still hang aloft and give us Bishop's ring? How can it be suspended so long?

Kiessling's experiments have led him to believe that the coronal diffraction does not take place immediately around the volcanic dust-particles, but rather around the minute globules of water or ice condensed on these particles as nuclei. Recent researches have shown that water-vapor may remain in the gaseous state below the temperature proper to its condensation, provided there is no solid or liquid matter present on which the condensation can begin; the change from the gaseous to the liquid state seems to desire the presence of some point of beginning, such as is furnished by ordinary dust, or by the far finer, ultra-microscopical particles always present in the air. It is in part for this reason that great cities in damp countries must be hopelessly foggy; however perfect the combustion in their numerous furnaces, unburned ash in very fine division must fly up the chimneys as long as wood and coal are used, and the finer the ash the better for the fog, when the coolness for condensation arrives. Now, in connection with this, there is a very peculiar point to be considered, concerning the distribution of water-vapor in the atmosphere. Water-vapor is a light, elastic, condensible gas, and its elastic lightness is always tending to throw it to an altitude where the cold of its expansion would require a part of it to condense into the liquid or solid state. It can, as yet, hardly be said that some minute point of beginning is absolutely necessary for all such condensation, but it may be safely asserted that the presence of dust aids and increases the rapidity of the process;

and it is this office that the finest and highest of the Krakatoa dust is thought to have performed. And here a peculiar cycle of operations, first suggested by Wollaston years ago, and generally neglected since then, may be reconsidered. So long as the water-substance is in the vaporous condition, it acts as a gas, and tends to expand upward; part of it would thereby be condensed, generally in the solid state, and on losing the gaseous condition the frozen particles would at once tend to fall toward the earth, impeded only by the presence of the thin air; but, after a certain length of falling, they would reach air warm and dry enough to allow them to re-evaporate, whereupon their vapor would again expand upward, and the cycle of operations begins anew. Wollaston suggested that the gases of the air might be thus affected by the extreme cold of upper space, and that a limit of the atmosphere might so be determined. There is, however, no experimental evidence yet adduced to prove that oxygen and nitrogen would behave in such a way, and the limitation of the atmosphere must be due to other causes; but the upward extension of water-vapor might be thus controlled. May we not, therefore, imagine that the vapor of the upper atmosphere, re-enforced liberally by steam from Krakatoa and other volcanoes in eruption at the same time, found its opportunity for condensation much improved for several months by the lava-dust from the same sources; and thus explain the brilliant sunsets and the strength of color in Bishop's ring during the winter of 1883–'84? But gradually the dust settles down, very slowly on account of its large ratio of surface to weight; and the vapor also decreases by slow downward diffusion; then the brilliancy of the display is lost, and the moderate residual of vapor, condensing as well as it can alone, produces only a fainter-colored ring and sunset glows that are visible only under especially favorable circumstances.

Be all this as it may, it is well to bear in mind that some such explanation must be found and accepted, for the facts of diffracting particles and their relation to Krakatoa are too well proved to be doubted, unless evidence not yet forthcoming shall appear in great strength.

The ring is doomed to disappear, and hence deserves a close watching. For, as Forel has pointed out, the outburst of Krakatoa must have had its rivals in ancient if not in modern times, and rings like Bishop's must in all probability have resulted from former dusty explosions. But these had all faded long before Bishop's ring appeared, and we must, therefore, conclude that it will fade away also. It should be carefully watched, especially from high-level stations, and those who make a persevering record of it should not fail to inform Professor Kiessling, of Hamburg, about what they see.

CAMBRIDGE, MASSACHUSETTS, *December*, 1885.

THE INFLUENCE OF INVENTIONS UPON CIVILIZATION.

By CHAUNCEY SMITH.

IN Westminster Abbey, that place where England honors her great men with burial, and records their names and achievements, there stands a monument bearing this inscription from the pen of Lord Brougham, who esteemed it one of the greatest honors of his life that he was called upon to record the nation's appreciation of the man in whose honor the monument was erected :

"Not to perpetuate a name
Which must endure while the peaceful arts flourish,
But to show
That mankind have learned to honor those
Who best deserve their gratitude,
The King,
His Ministers, and many of the Nobles
And Commoners of the Realm,
Raised this monument to
James Watt,
Who, directing the force of an original Genius
Early exercised in Philosophic research,
To the improvement of
The steam-engine,
Enlarged the Resources of his Country,
Increased the Power of Man,
And rose to an eminent place
Among the most illustrious followers of Science
And the real Benefactors of the World."

The world has always paid homage to its distinguished warriors, statesmen, orators, poets, philanthropists, artists, historians, travelers, and to all who have left the impress of their works upon the history of mankind.

It is not until recently, however, that inventors have received a large share of these honors. As a class, they hardly had an existence till within a hundred years. Within that time they have risen to the highest place among those who, in the language of the eulogy I have just quoted, best deserve the gratitude of mankind, and by their works they have made greater changes in the face of society, and in the relations of civilized man to the physical world, than all the warriors and statesmen who have flourished since the commencement of the Christian era.

I am not unmindful, in making this statement, of the great changes that followed the introduction of the Christian religion, or the advent of Mohammed and the rise of his religion, of the consequences which followed the establishment of great empires like that of Charlemagne, or of the results of geographical discovery, as in the discovery of America or of the passage to India.

I am well aware of the difficulty of comparing the magnitude or importance of such things, for instance, as the art of printing, the steam-engine, or the railway or telegraph, with a new form of religion, or the establishment or overthrow of an empire, or the introduction of new forms of government. One man may attach much higher importance to some of these things than another would do, and a very much higher importance to them at one period of his life than at another.

It may seem absurd to some persons to make any comparison, for instance, between the benefits flowing from the introduction of Sabbath-schools and those which have followed the invention of friction-matches; between the results due to the invention of spectacles and the consequences which followed the Reformation. And yet it is easy to see that each of these things must have had an important influence upon the physical, social, and moral condition of men, upon their habits of thought and of living, and upon their comfort and happiness. There is, therefore, some just relation between the value of these things to men, and it will not be unprofitable to spend a little time in considering how much we owe to inventors for what we have and what we are.

It is my purpose this evening to briefly bring into view, if I can, the service which inventors have rendered the world, and the part which inventions play in the moral and social condition of man. I shall point out in some cases the extreme simplicity of the inventions, in others the wonderful results which have flowed from them.

I shall refer not merely to what are called great inventions, but to some which seem to be very small. I shall very likely speak of nothing with which you are not all more or less familiar, but I may possibly suggest reflections which are interesting but which seldom come to our minds, for the very reason that we are so familiar with the things to which they relate; and I think that I may be able to show that there are no other men to whom the world is so much indebted as to its inventors, no others who so well merit its honors and deserve its gratitude.

We do not often stop to think how little man has or enjoys that is not the fruit of invention. Things which man has long had we have ceased to think of as inventions, and we are apt to apply that term only to modern things—to things the origin of which we know. Yet it will be hard for any of us to name anything which we use or enjoy which is not an invention, or the subject of an invention, in its adaptation to our use.

The air we breathe and the water we drink are provided by Nature. But we drink but very little water except from a cup or vessel of some kind, which is a human invention. Even if we drink from the shell of a gourd, we are using a thing which, in the shape we use it, is a human contrivance, and the contrivances which man has devised for obtaining water and distributing it have been among the most wonderful and ingenious of any which have occupied the human mind. Bountifully as Nature has provided water and placed it within the reach of man, yet we do in fact get or use but little of it except by the aid of inventions.

The air surrounds us at all times and we can not help using it if we would; but, if we want it either hotter or colder than we find it, we must resort to some invention to gratify our want. If we want it to blow upon us when it is still, we must set it in motion by some contrivance, and fans among other things have been invented for that purpose. A large amount of human ingenuity has been expended upon devices for moving air when we want it moved, upon fans, blowers, and ventilators.

How small a part of our food do we take as animals do, in the form provided by Nature, and how very large a share in some form contrived by man! We drink infusions of tea or coffee without thinking that the compounds are human inventions. How large a place the milk of the cow has in the food of man, but how little of it could he have but for a multitude of contrivances! We think of butter as we do of milk, that it is a production of Nature; and so it is, but its separation from milk is an invention which has been followed by a host of inventions to effect the separation easier or better.

Sugar is a production of Nature, but little known a few hundred years ago. Separated from the plants in which it is formed, it is an invention of man. The savage who first crushed some kernels of wheat between two stones, and separated the mealy interior from the outer skin, invented flour, and the human mind has not yet ceased to be exercised on the subject of its improvement.

Probably the earliest inventions of man had reference to the procuring and preparing of food, and the ingenuity of man is exercised even now upon it more eagerly than ever before, and the power of man to produce food has been increased during the last fifty years more than it had been for a thousand years before.

Fifty years ago, a large part of the wheat and other grain raised in this country was cut, a handful at a time, with a sickle, and a man could not, as a rule, reap more than a quarter of an acre a day. An instrument called a cradle was beginning to come into use, and with that a man could reap about two acres.

Within fifty years inventors have given the world the reaping-machine, with which a man and two horses will cut from fifteen to twenty acres a day.

Fifty years ago the grain was almost wholly thrashed from the straw by pounding it upon a floor with a flail. If I remember correctly, a man sometimes received one bushel in ten for thrashing, and from ten to twenty bushels must have been a day's work.

Now a machine will thrash out hundreds of bushels in a day, at an expense of a very few cents a bushel.

Inventions have changed the meaning of words. When I was a boy, a reaper was a man who reaped grain with a sickle, and a thrasher was one who thrashed it with a flail. Now, reapers and thrashers are machines driven by steam or horse-power.

For what part of our daily bread are we not indebted to inventions? Some of the fruits of the earth we eat as Nature gives them to us, but how much even of them do we take directly from the tree or shrub or plant which produced it, and eat without the aid of invention?

All our animal food comes within our reach and is prepared for use only by the aid of inventions.

Hooks and nets and spears give us all we have of fish. The fish-hook is a very simple contrivance. Is it a great invention or a small one? If the fish-hooks should all be suddenly destroyed, together with the ability to make them, would not the loss of the invention be a greater calamity than any which has befallen the world for a thousand years? If so, were not the inventors of that instrument, and those who have improved it, real benefactors to the world?

Could we get along without needles? Could we give up pins without a sigh? Are knives and forks and spoons a necessity? They are all among the simplest things that man makes, yet he has not obtained them without a great deal of mental labor; without the exercise of powers of invention of a high order.

It is less than fifty years since the little articles called matches have come into use. They are now so common and so cheap that we use them almost as we do air and water, without thinking at all of their real value. How few there are of us who do not use them every day, and many times a day, and how inconvenient it would be not to have them! But, when I was a boy, nobody had them; nobody could have them, for they did not exist. In the country-houses, at least, the greatest care was exercised not to let the fire go out upon the hearth, because in such case it became necessary to send to a neighbor's, often at a distance, for a fresh brand. Every night the live coals upon the hearth were carefully buried in the ashes to preserve them alive for the morning. In spite of this precaution, the fire was often lost. I have been sent many a time, in such cases, to a neighbor's in a cold morning to get a burning brand to start the fire at home anew. Nobody now thinks of taking any pains to preserve a fire, for it is easier to start a new one with a match than to preserve an old one. A very common way of lighting a candle in the house when darkness came on was to take, with the tongs, a coal from the fire—wood-fires were then used—and blow it, applying the wick of the candle to it at the same time. Sometimes it could be lighted very readily, but oftentimes it could be done only by the exercise of a good deal of skill and patience. A great deal of vexation and trial of nerves and temper has been saved to the world by the invention of matches, and the comforts of our homes increased in many ways. Perhaps, therefore, the comparison I suggested between friction-matches and Sunday-schools is not so incongruous as it may at first seem.

There were some devices known in those days for obtaining a light or fire artificially, but they were inconvenient, somewhat expensive, and not in general use. The tinder-box was one of them.

A gentleman not much older than myself told me not long since that when he was in college one of his classmates was rich in the possession of a tinder-box by means of which he could strike a light and a fire in case of emergency, and he gave me a humorous account of the process of striking a light, involving considerable skill, much patience, and, as he said, some swearing.

A great many boys have been taught in Sabbath-schools not to swear, but a great many more have doubtless, by the use of friction-matches, escaped numerous occasions and temptations to swear, and wives have no doubt by this invention been saved from innumerable scoldings for not covering up the fire properly at night.

There is one curious fact about matches which I do not remember to have seen mentioned. We speak of them as a recent invention, but they are only an improvement upon a very old invention. Travelers among savages have generally, if not universally, found that they possessed the art of procuring fire when they wished, by rubbing two pieces of wood together till the heat generated by the friction between them caused one of them to take fire. It is described as a pretty crude way of working, calling for considerable skill and some labor and patience. Perhaps the date of the invention may go back to the earliest use of fire by man. Yet the invention itself is essentially that which we practice when we strike a match. We rub the match upon another substance, and the heat generated by the friction between the two causes the match to take fire. The improvement which the civilized man has made upon the invention of his savage ancestor is to coat the end of a piece of wood with a little composition of matter which takes fire at a lower temperature than the wood itself, and burns more rapidly. Simple as the improvement is, it took the world a long time to get it, and its inventor made a most important contribution to the comforts of man.

I was forcibly impressed a few years ago with the value to the uncivilized man of the simplest inventions of the civilized man, as I watched an Indian at Lake Superior at work upon a birch-bark canoe. He had for tools only a knife, a hammer, and an awl, but I suppose he must have used a hatchet to procure the wood and bark of which the canoe was built. It was slow work even with these tools, and it was difficult to believe that he could have built the vessel with the blunt instruments with which his ancestors had to be content before they came into contact with the white man. What an acquisition the white man's fish-hook must have been to the Indian!

Fifty years ago a large part of the people of this country had no other resource for artificial light than the tallow-candle. I remember it, and the vexations attending its use, the difficulty of lighting it by a coal of fire, the constant snuffing it required to make its light tolerable, and its constant tendency to melt and besmear everything in its vicinity. I venture to say that any of you would consider it an intolerable hardship to be compelled to use it and nothing else. Those who used oil-lamps got a little better light, but not much less discomfort. Gas was used only in the large cities. But the inventors have been busy in providing a new material for illumination and the means for using it and in cheapening their production; and now in kerosene and in kerosene-lamps, both of which have been called into existence within thirty years, the poorest people can enjoy, at the most trifling expense, a light better far than anything which anybody could command at any price before the invention of gas less than a hundred years ago.

Can we estimate the comforts of the homes of the country due to these inventions? Can we estimate the greater value of the evening hours for work, or study, or reading, which these inventions have given them?

I remember that my mother had a vial of what she called rock-oil, which she thought very good for sprains or bruises. It was said to have come from Western New York. I now suppose it to have been petroleum. Petroleum has been known to man for a long time, but it had no value till it came under the hands of the inventor. He has made a worthless article a blessing. Invention marks every step of its history. Petroleum in this country lies deep in the earth. By the aid of recent inventions man reaches it. By their aid he stores it, for it is a dangerous and difficult article to keep and transport. By invention, man has changed its character. And now, not only this country, but the whole world, is lighted by this new material. Yet all the invention which has been bestowed upon it would have been wasted but for another class of inventors and another line of inventions. The lamps had to be invented or improved, and hundreds of men have been engaged on their improvement for years.

And now inventors have entered a new field and given us a light for our homes and streets almost as brilliant as that from the sun itself, from that agent which, since the world began, has lighted up the sky in angry flashes only to alarm timid and superstitious man.

It is a curious and interesting exercise to take any common article of daily use and inquire how much invention has been involved in its production; what inventions have preceded it; what ones, if any, it has supplanted, and what ones it gave birth to; what consequences followed its introduction, and what part it plays in the welfare of man.

The inquiry soon becomes a bewildering one.

Take paper, for instance. I believe we are indebted to the Chinese for its invention. Do we ever think of it as one of the great inventions of man? Why, it is nothing but rags ground up in water to a pulp, spread out in a thin sheet, and dried. I think the art of making paper has been known in Europe less than a thousand years. It has taken the place of parchment for writing. It made the art of printing possible. It made the newspaper possible, and especially the daily paper. The multiplication of pictures by engraving could not be carried on without it, nor the modern art of photography, to which I shall refer again. We attach great value to a system of general education as one of the most important agencies of modern civilization. But the first requisite of such a system is cheap books, and for these paper is the only thing we could use. Would any of you undertake to enumerate within the next half-hour all the uses to which paper is put? Would you undertake to name and describe all the kinds that are used?

Paper is largely made of rags. Rags presuppose the existence of cloth. Cloth is the product of two distinct inventions, spinning and weaving. Spinning and weaving are very old inventions, but even in their simplest form they involve the use of still older inventions. Whatever material is used for paper, a long line of antecedent inventions is involved in its use.

Paper must, I think, rank as one of the great inventions of man, and, if the heathen Chinese had given the world nothing more than this, he would have made no small contribution to the progress of civilization.

I have said that paper is made from rags, and that cloth implies the arts of spinning and weaving. But it also implies much more. To me, one of the greatest marvels of human industry is a yard of cotton cloth at the price at which it is sold. The price of a yard of cotton cloth of the kind called print-cloth, and which when printed becomes calico, is less than four cents, and the cotton itself costs half this sum. What inventions are involved in the raising of the cotton and its transportation to the mill where it is to be converted into cloth! Of course we all think of the cotton-gin, because that invention was made with special reference to the production of cotton, and has been much referred to as a striking example of the results which flow from an invention.

But the gin comes into use only after the cotton is grown. Of course the common agricultural inventions are used in raising cotton: the plow, the hoe, the machinery by which the plow is made, the arts of making iron and steel, including the machinery employed, the harness for the horse or mule which draws the plow, and the art of tanning the leather of which the harness is made. Recently planting or drilling machines for planting the seed have come into use, and artificial fertilizers—the product of the chemist's art—and the mechanism for distributing it over the ground. Even after the plant has begun to grow and before it is ripe, invention must often be called into play to protect it from the ravages of insects, and not a few devices, mechanical or chemical, have been called into existence for this purpose.

The ripe cotton-balls are still picked by hand, though inventors are busy with the problem of picking it by machinery. It is gathered into baskets or bags, themselves inventions, to be transported by a cart, another invention, to the gin-house, still another invention, where it comes under the operation of the gin to separate the cotton from the cotton-seed.

Would you like to know what the cotton-gin has done toward making cotton cheap, toward enabling enough to be sold for two cents to make a yard of cloth? An acre of ground is expected to produce at least one bale of cotton, which weighs four hundred pounds or over. Before the cotton-gin was invented, a man could pick about four pounds and a half of cotton from the seed in a day; so that it took a man about ninety days to separate the cotton which he could raise on an acre from the seed.

Whitney invented the cotton-gin, and with it a man could separate seventy pounds. In other words, he could do the work in six days which before took him ninety days. The invention was made less than a hundred years ago, but inventors have been busy with it ever since, improving it year by year, and now it turns out four thousand pounds a day! In other words, a single machine will do the work of about a thousand men.

As soon as the cotton is through the gin it must be pressed into bales, for the cotton is a light, bulky article which can not be transported without confinement and a great reduction of bulk. So another invention is required, the cotton-press. Some of these presses are wonderful machines. They embrace a steam-engine, a force-pump, and a hydraulic or hydrostatic press, and give a pressure of 4,000 pounds to the square inch.

The cotton-bale is surrounded by a coarse cloth called gunny-cloth, itself the product of another line of inventions, including the arts of spinning and weaving, and made by special machinery. The bale must also be hooped with iron hoops, involving again the inventions pertaining to the manufacture of iron, but in addition the machinery for rolling it into thin and narrow strips, and I think this embraces the art of rolling iron into round bars and drawing it into wire.

These hoops must at last be fastened around the bales, and that has called for the invention of peculiar fastenings called cotton-bale ties.

At length, through all these inventions, we have the cotton ready for market and transportation to the factory, where it is to be made into cloth.

This demands the use not only of the cart or wagon, an old but important invention, but the railroad, the car, and the locomotive or the steamship, or perhaps both of them. It is bewildering to think of the inventions involved in these, and I could not even enumerate them in the time I have, if I knew them all.

When the cotton reaches the factory, an invention stands ready to unload it from the cars and deposit it where it is to be used. The iron bands are removed by some instrument invented for the purpose, and the cotton is released from its confinement. It is submitted to machinery to free it from dirt and restore it to something of its original light, flocculent character, and it then enters a machine which spreads it out into a long sheet like cotton batting. This sheet in turn is stretched out into a long, soft rope, called a roving. Successive machines, four or five in number, I believe, extend the roving and make it smaller, till it is smaller than a common pencil. It then goes on to a spinning-frame and is twisted into a thread ready for weaving. Our two cents' worth of cotton has been drawn out into a fine thread more than 7,000 yards long, each inch of which has more than forty twists in it.

Shall I stop to tell you what man has achieved in the art of spinning? The art, as you know, is a very old one. Its invention lies back of the records of history. It was practiced a long time in its primitive form as a mere manual operation. The wool or flax or cotton was carried on a distaff. The thread was drawn out and twisted by means of a spindle held in the left hand, by which it was set to whirling while the fibers were drawn out of the mass and guided by the fingers of the right hand. The art was practiced in this crude way for ages, and it is so practiced now in some countries.

A book which describes this process says it was an obvious improvement to set the spindle in a frame and set it whirling by a band passed round it, and around a large wheel which was in revolution. But it was not so obvious that anybody, through long years, thought of it till about three hundred and fifty years ago. I believe this improvement which constituted the common spinning-wheel was invented in Germany. A woman could spin with it much faster than in the old way, but she only kept one spindle employed. A little more than a hundred years ago the spinning-frame was invented in England, in which a number of spindles were set and kept in operation at the same time. At first only eight spindles were used, but now several hundred are used in one frame.

There were three leading inventors at this early date who each made important improvements in spinning—Hargreaves, Arkwright, and Crompton. With a common wheel a woman can draw out a thread about four miles long in a day. On a modern spinning-frame she can take care of 800 or more spindles and spin threads the aggregate length of which would be more than 2,000 miles.

On these machines cotton yarn has been spun so fine that one pound of cotton would make a thread 335 miles long, and as a feat threads have been so fine that a pound of cotton would reach nearly 5,000 miles!

To go back to our two cents' worth of cotton, which has been converted into yarn. It is subjected to the action of several machines before it reaches the loom, where it is converted into cloth. Weaving, like spinning, is old, and some sort of machinery has always been employed in the process, but the power-loom of our factories is a modern invention. I sometimes think it is the most wonderful machine used. To make one yard of cloth, a shuttle carrying the filling-thread is thrown across the web perhaps 1,500 times, at the rate of a hundred crossings a minute.

There are looms which weave cloth more than three yards wide. There may be nearly 10,000 warp-threads in cloth of this width, and 5,000 filling-threads in a yard carried across the web at the rate of nearly a hundred throws a minute.

The art of printing has always been recognized as one of the great inventions of man. It is over four hundred years old, but after its first introduction very little improvement was made until the present century. Since then it has presented a rapid succession of the highest efforts of mechanical genius. I shall not attempt to follow their history or describe their character; but it is interesting to know that they have been made almost wholly by English or American inventors, and that more has been done in this country than in England. The wonder of modern printing is that it can be done so cheaply. You have all seen the series of publications by the Harpers called the "Franklin Square Library." I bought a copy for ten cents, the regular price. It contained thirty-six printed pages. I had the curiosity to estimate the number of words on a page and calculated it roughly at 2,000. That would give for the whole book 72,000 words, all for ten cents. Can you form a conception of the number of inventions which has made such an achievement possible? I think a modern daily newspaper is, however, one of the greatest wonders of the age.

I buy a morning paper, the "Boston Herald," for instance, for two cents. I read it on my way to Boston in the horse-cars and abandon it at the end of the trip, not because it is worthless, but because I have obtained from it what I wanted and it will not pay to preserve it for any other person or for future use. Now, what do I buy for my two cents? The physical thing that I buy is a sheet of paper and a certain amount of printers' ink impressed upon the surface of the paper in the shapes of letters and words. It is a wonderful fact that man can spread out the fibers of various vegetable substances into a thin, uniform sheet like that of paper, that he can cover such sheet with signs which can be made to express every passion or emotion of the human heart, every conception of the mind, and every fact in nature! Scarcely less wonderful than the fact that he can do it at all is the fact that he can make such a sheet of the size of the "Boston Herald" for two cents. It would take a volume to record all the inventions which have been made relating to the manufacture of paper alone to make such a result possible, and another for the inventions relating to printing. But the inventions relating to paper and printing would not of themselves enable "Boston Heralds" to be printed. The "Herald" is not made and sold for the paper and ink of which it consists, but primarily for the news it contains of what has taken place only the day before all over the world. You will find in the "Herald," as you know, or any other morning paper, day after day, the news of what took place the day before, not in Boston or vicinity alone, or even in Massachusetts or New England, or in this country, but in Europe, Asia, and Africa as well.

Through the potency of modern inventions you may perhaps to-morrow morning shudder over the horrors of a railway accident taking place at this moment thousands of miles away. Not till within a short time, and only through the works of the inventor, did a railway accident become possible.

You may perhaps read that a palace of the Emperor of Russia has been blown down with dynamite. Will you stop to think that dynamite is a new invention, or that the telegraph which brings the news was unknown fifty years ago?

The paper may tell you that Mr. Edison has perfected his electric light and is at this moment illuminating many cities, and you will speculate upon the effect that the announcement will have upon gas-stocks, but will it occur to you that neither gas-stocks nor gas was known a hundred years ago, and that till within less than half that period man had but little more control of electricity than he has now of earthquakes?

Now, consider for a moment how this facility for transmitting intelligence must affect society in one of its most important aspects. A great calamity falls upon some distant city or community. If the news of it reached us, as it would have done a century ago, only after the lapse of days, or weeks, or months, and if friendly help can be given only after the lapse of a similar period, we may be touched with pity, but there will arise but little sense of sympathy or generosity or duty.

But when the intelligence reaches us almost at the moment of the occurrence of the event, and we are conscious that it lies in our power to help, the sympathies of thousands are awakened, their generous impulses are touched, and they recognize a moral obligation to bestow needed help, because it can be made immediately available. The duty springs from the ability, and the ability is the fruit of invention. It may seem a strange assertion to many persons, but I believe it can be shown to be true, that the development of the moral nature of man has been as directly dependent upon invention as has his physical comfort.

[*To be continued.*]

THE MUSKET AS A SOCIAL FORCE.

By JOHN McELROY.

WHAT has always greatly puzzled the historical student has been to account for the debasement of the mass of mankind that took place during the long night of the dark ages.

In the lustrous afternoon which preceded that going down of the sun of civilization for a half-score of centuries the people of Europe seemed to be enjoying a fair measure of liberty and self-respect. In decaying Rome they were poor, for the wealth had agglutinated into the hands of the few. In barbaric Germany they were poor, because the wealth had not been created. But they were all free, and highest and lowest stood on a common plane of manhood. In spite of apparent caste distances, the substance of equality was yet a permanent and controlling quality. Everywhere the high and the low were but an arm's length apart, and the arm that measured that distance was a sturdy, manly one, usually quite ready to give and return blows. South of the Alps the proudest noble was within reach of the torch and dagger of the humblest plebeian. North of the great mountains no chief was so powerful as to be beyond the spear-thrust of the meanest of his followers. No man need be wholly abject, for he was always within striking distance of his oppressor. The turbulent Roman proletary resisted encroachment on his rights with riot and insurrection. The brawny Teuton knew no master but his elected chief, whom he deposed with scant ceremony the moment the leader's hand or nerve weakened.

A thousand years later, when day dawned once more, an amazing chasm was found to have opened up between the high and the low. The few were as gods in their power over the lives and property of the many. The low were as abject in their degradation as the beasts that perish.

In each community there had come to be one who lorded it like a wolf in a village of prairie-dogs. He dwelt on a hill-top, in a castle of massive masonry, clad himself in fine raiment, and gormandized, battened, and rioted. Where he was, there was "gude chere in knightlie hall," there were "wassail" and "revel" and "rouse" and all the other fine-named forms of the dull gluttony of feudal days.

In order that this one man might stale his palate with dainties, thousands of other men — "serfs," "churls," "villeins," "hinds," "peasants," etc.—were deprived of all but the smallest amount of coarse food that would enable them to live, labor, and reproduce their kind! In order that he might clothe himself in piled velvet, and his lady "walk in silk attire," they and their wives were confined to a single coarse garment. In order that he might sleep on down in marble halls, they were restricted to a couch of rushes in a fireless and windowless hovel.

Now, how did this man on the hill-top "so get the start of the majestic world" that all the kernels and sweetmeats in the lives of thousands were his, while only the rinds, the husks, and the shells, were thrown to them?

The answer is easy: It came about through the adaptation of the horse to warfare, and the development of defensive armor. Improvements in armor made the aggressive, domineering man invulnerable to spear and dagger in the hands of those whom he would oppress. Ensconced in tempered steel, and moved by a horse's mighty motive power, he was irresistible to those who could only oppose to him their own unprotected thews and sinews.

It is significant to notice how constantly the idea of the horse is associated with the elevation of the few and the degradation of the many under feudalism. In all the tongues of Europe it is the "Man on Horseback" who is the lord and despoiler of the people. The Germans called him "Der Ritter" (the rider), and cognate words designated him in all the divisions of the Teutonic speech. In French the horse is *un cheval*, and the tyrant of fields and people a *chevalier*. The Portuguese called him a *cavalleiro*, the Spaniards a *caballero*, and the Italians a *cavalliere*—all direct derivatives of the Greek and Latin *kaballus*, a horse. In England, where, for reasons that shall be given presently, the people were not crushed down to anything like the extent of their class on the Continent, the name given the Man on Horseback shows that he never acquired any such arrogant supremacy. There he was merely a knight (Anglo-Saxon *cniht*, a youth, an attendant, a military follower).

In the far-off days, ere the centuries had entered their teens, the gentleman who was burning with enthusiasm to earn his bread by the sweat of some one else's brows proceeded differently from what he would now. Contrasted with the neat finish of an "operation" in stocks or produce, or the Louisiana Lottery, his methods seem crude and clumsy. Nevertheless, like the methods of most of the processes of primitive people, they were quite effective.

He provided himself with a stout horse and a suit of armor combining all the latest improvements. He then set himself up as the lord and "protector" of as large a collection of land-tillers as he could cajole or force into accepting his "protection." Sydney Smith wittily described a lawyer as "a gentleman who rescues your estate from your enemy and keeps it himself." It was on this principle that these "protectors" acted. They took the entire product of the husbandman's labor as a reward for their friendship and courage in protecting him from spoliation by some one else!

The period was the Golden Age of Might. It was the day of the absolute monarchy of Brawn, and the strong right arm was the court of first resort and tribunal of final appeal. Centuries of Egyptian, Greek, and Roman civilization had developed the science of jurisprudence into laws and customs which were fairly equitable in securing ownership of person and property. But moral chaos came again when the Gothic cataclysm rolled over Europe. There was no longer any recognition of a man's right to anything to which he could not hold on by main strength.

The gentleman whose factory-plant, office-furniture, and stock in trade consisted of a stone castle, a broad-haunched horse, a business-suit of spring-steel, and a twenty-foot lance, held thirteen trumps in the game as it was then played. To propitiate him—to gain even the privilege of living in unutterable wretchedness and squalor—freemen surrendered their lands to him, gave up all their labor's products, and even yielded to him such of their women as his momentary caprice might demand.

The Men on Horseback divided all the arable lands of Europe among them. Naturally they had hot disagreements as to who should have the monopoly of plundering a given valley or plain, and carried on the dispute with much clamor and fighting. In spite of the ornate descriptions of romancers and ballad-singers, this latter was not of a very sanguinary nature. So completely was armor finally made to answer its intended purpose that there are records of "battles" between imposing arrays of armored horsemen, which lasted all day, but in which not a single life was lost. The worst likely to happen to any combatant was that he be unhorsed, pinned to the ground by the weight of his armor, taken captive, and forced to pay ransom. "The knights of old" were warriors "for revenue only."

The only likelihood of any considerable slaughter was when the wretched serfs—goaded to madness by their wrongs—revolted against their despoilers, and strove against them with pikes, scythes, bills, and similar ineffective weapons. Then the wolf-hounds of murder were let loose. Cavaliers at war with one another would make a truce, to join in slaying "rebellious hinds." The last great battle of this kind was in the "War of the Jacquerie," in 1348, where nine thousand poor serfs were massacred in the French town of Meaux, and in the three weeks that the hunt lasted more than twenty thousand were slain. So fond were the chevaliers of this sport of hind-killing that it was not an uncommon thing for them—before or after one of the great armor-battering matches which they called battles—to turn upon and slaughter the poor wretches whom they had mustered to attend them to the field. King Philip of France opened the battle of Crécy, in 1314, by charging his Genoese cross-bowmen with his chevaliers, and slaughtering them right and left!

The only men who resisted successfully these mounted ravagers and maintained for themselves some of the rudimentary rights of humanity were the merchants and artisans in the walled cities of Italy and Flanders; the Swiss, in their mountain fastnesses; and the insular English, whose dreadful long-bows would send arrows a cloth-yard in length through the best Milanese plate-armor. In consequence of the excellence of the English archery the Man on Horseback throve there so poorly that the worst condition of the English people in the middle ages was always better than the best condition of those on the Continent. Nor could the Man on Horseback's charge avail against the Italian and Flemish burghers, behind their solid walls.

In 1386 a horde of Austrian cavaliers, who were striving to reduce the Swiss mountaineers to serfdom, penetrated some distance into the Canton of Unterwalden. The ground was so rugged that they had to dismount, and proceed on foot. They were compelled to cut off the long toes of their shoes in order to be able to walk. They were suddenly confronted at Sempach by a small band of determined peasants. Arnold Struth von Winkelried performed his immortal act of self-sacrifice, by breaking with his naked breast the firm front of lances, and his companions rushed in and slew the clumsy dismounted horsemen. This and similar victories secured the freedom of the dwellers among the Alps, and bred there a race of men who were to become the flails to help beat feudalism to fragments.

With these exceptions the print of the war-horse's hoof was on every fertile acre in Europe. The long lance of his rider was the sickle which reaped the fruit of every man's labor. Greedier and greedier every year grew the hungry horde of steel-clad riders. Less and less of the comforts of life they left the abject peasantry. Nearer and nearer the condition of the laboring cattle sank those who delved and planted, and reaped and garnered.

The horsed harpies knew themselves well. They delighted in the character of birds and beasts of prey, and were proud to make lions, tigers, bears, eagles, and hawks, the cognizances by which they were known.

The sole mitigation of this reign of misery for the many was that, in spite of their armor, these rapacious harriers occasionally devoured one another. The strongest slew the less strong; the lions killed off some of the hyenas and jackals; the eagles tore to pieces the kites and hawks. The strongest and craftiest lord of some single hill-top killed off a number of his associates in the robbery business, or seized their lands after they had drunk and gorged themselves into the grave, and became lord of all the hill-tops commanding the entire plain or valley

—became a prince, duke, count, or margrave. The same process welded several of these principalities, counties, dukedoms, or marquisates into a kingdom. The advantage to the people of this was, that they had fewer masters to feed and clothe, and the exactions upon them had somewhat more system. Spain and France became the leading nations of Europe because this process of aggregation went on more rapidly there than in Germany, Italy, Austria, and elsewhere.

Progressive people everywhere saw clearly what an improvement a king was upon the Man on Horseback, and became his advocates and supporters.

If, however, there had been no brighter hope for mankind than was contained in the evolution from a swarm of petty tyrants to a monarch, the outlook would have been dark indeed. A millennium of that kind of progress would scarcely have brought mankind up to the plane occupied by the Russian serf to-day. Fortunately, another force was born into the world. Whether "black Barthel," the German monk, discovered gunpowder, or whether Friar Bacon preceded him, is of little consequence. The fourteenth century was yet quite young when *somebody* found out that a mixture of sulphur, niter, and charcoal would deliver a very heavy blow, and, as it was a day when heavy blows commanded the highest price of anything in the market, the attention of all progressive men was quickly turned to it. If we except the rhythmic beat of the vibrating battering-ram, the sturdiest blow then known was that which the momentum of a galloping horse delivered at the point of a lance. But even with the first rude tubes of wood and leather, or hooped iron boxes, the new force struck a blow that dismounted the doughtiest cavalier, and breached the thickest walls.

It began its work for mankind as the slave of kingcraft. Only kings could afford the costly "mortars," "vases," "culverins," "perriers," "falcons," etc.—only monarchs could employ the skilled artisans who manipulated these

> " . . . mortal engines whose rude throats
> Th' immortal Jove's dread thunders counterfeit."

It had to serve an apprenticeship to autocracy before it became democracy's mighty minister. It prepared the way for its future mission, even then, for kings used it to dismount cavaliers, and beat down their castle-walls. The despotism of the Man on Horseback began to crack around the edges, and in the rifts and fissures of the iron tyranny fell the mustard-seed that was to grow up into the world-shadowing tree of liberty. Its development was dishearteningly slow, however. It was a day when all intellectual processes were as slow as the pace of the overladen battle-horses, and invention crawled languidly, instead of running and leaping, as to-day.

So it was fully a century and a half after Ferdinand IV used the first cannon to aid in capturing Gibraltar, before we find a Man on

Foot using the first crude attempt at a musket. A favorite type of cannon were then called "bombards," and he styled this diminutive copy a "bombardelle." Nothing could have been ruder and more primitive in design and construction. It was merely a tube—probably about as large as a section of two-inch gas-pipe, but not so well made—with one end closed, and near that a small hole for a vent. It was securely fastened to a stout stick, the end of which rested on the ground to receive the recoil. The Man on Foot, clad in light armor, held the bombardelle up, while a comrade touched a live coal to the vent. Powder was as yet very weak, and it was necessary to use a ball weighing about a pound, in order to do any execution, even at the range of a few score paces. Nothing illustrates so well the amazing slowness of the evolutions of the heavily armored men and horses as that this clumsy weapon, which probably never had an effective range of one hundred yards, and could not have been fired oftener than once in five minutes, could have rendered any service whatever. With no facilities for aiming, it was by the merest accident that it struck the cavalier, unhorsed him, and put him at the mercy of his enemies on the ground, but even this chance was much gained.

The power was now getting into the hands in which it belonged. Invincible infantry means democracy sooner or later, just as inevitably as the invincible Man on Horseback meant aristocracy, and artillery autocracy. The foot-soldier, even though he be the myrmidon of a king or the henchman of a lord, is, unconsciously perhaps, the enemy of noble and sovereign. He comes from the people and returns to the people. Whatever he may do at behest of liege or lord is an object-lesson to his fellow-commoners as to what they may do in opposition. Every step taken by his masters to make him more formidable is

> "Bloody instruction, which, being taught, returns
> To plague th' inventor."

The first cavalier that was rolled in the dust by a bombardelle-ball reopened the era of the people which had closed when Rome's matchless infantry disappeared from the fighting world. Thenceforward the final overthrow of feudal and kingly despotism and the triumph of the people became merely a question of improvements in the bombardelle. In vain the Man on Horseback strengthened his armor and thickened his castle-walls. The stronger his armor, the more he was weighted down; the slower he moved, the longer he was within striking distance of the man with the "hand-gonne." Nor could the thickening of his walls keep pace with the improvement in cannon-making, the substitution of iron balls for stones, and the strengthening of gunpowder.

In those days the Germans called cannon "boxes" (Büchse), from the manner in which they were built up. They devised a fork or hook (Haken) to support the bombardelle and afford better aim, and called the improved arm a "hook-box" (Haken-büchse), whence the various forms of "harkebus" and "arquebuse" in the different languages. Presently the tube, growing still lighter as the improvement in the manufacture of powder enabled the weight of the ball to be continually reduced, was laid in a stock similar to that of the famous Genoese cross-bow, and a priming-pan was placed at the vent. A little later a still more valuable improvement was made by attaching to the rear end of the barrel a piece of iron shaped like the letter S, and celled a "serpent." The upper end of this carried the tip of a lighted rope-match into the priming-pan when the lower end was moved by the finger. When a trigger and springs were subsequently added, the Man on Foot had the historic "matchlock," with which he fought for two and a half centuries.

Thenceforward the march of improvement was steady and at an accelerating pace. The "hand-gonne" gained continual access of power over the Man on Horseback, and as continually its use became more familiar to the people at large. By singular concatenations, which some people are fond of terming "providential dispensations," the men advocating the best ideas got hold of the best improved guns and had the most of them.

In 1477 the Swiss, who had grown so self-confident that they did not hesitate to descend from their mountains to attack the Men on Horseback on the plains, came down from the passes of the Vosges Mountains carrying from six thousand to ten thousand of these firelocks, and at Granson, Morat, and Nancy, literally destroyed off the face of the earth the arrogant Charles the Bold and his rapacious Burgundian chivalry. Guns which combined the improvements of another half-century enabled the Spanish footmen to smite the French chevaliers hip and thigh at Pavia in 1525, where Francis I "lost everything but honor," and the Spanish infantry became the first in Europe, a position it held for nearly a century, until, as the instrument of ecclesiastical tyranny in the Netherlands, it was defeated by the superior guns and tactics of the Dutch infantry under Maurice of Nassau.

A few decades later the use of paper cartridges by the Swedish musketeers gave them an advantage which greatly aided Gustavus Adolphus to widen the horizon of Liberty by his successful warfare against the hordes of civil and religious despotism. Nearly simultaneously firelocks in the hands of Cromwell's superb foot-soldiery were preaching irresistible arguments on the Rights of Man to Charles I's cavaliers.

The mediæval Man on Horseback may now be said to have permanently disappeared from the field of battle. Granson, Morat, and Pavia had showed him of how little avail it was for him to cover every inch of his own body and that of his horse with the best steel, and he began stripping it off, to gain celerity of movement under the dreadful fire. By the end of the seventeenth century it was all gone but the helmet and breastplate, and these were not worn by him, but by his mercenaries. As the musket now enabled battles to be determined by the superior manhood of superior numbers, and there was always a great deal of downright killing, he lost his keen interest in war as a business, and loved best to fight by proxy. The plaint of the fop to Harry Hotspur was an anachronism of about two hundred years for Henry IV's reign, but it expressed pretty accurately the feelings of the aristocracy in Shakespeare's time:

> "And that it was a great pity, so it was,
> This villainous saltpeter should be digged
> Out of the bowels of the harmless earth,
> Which many a good tall fellow had destroyed
> So cowardly; and but for these vile guns
> He would himself have been a soldier."

The Man on Horseback still continued to don his suit of "complete steel" from time to time for nearly a century after it was last worn in line of battle, but it was only to impress the popular imagination and enhance his personal appearance when he took part in the pageantry of government. The long warfare between him and the king had ended in his entire subjugation, and he was now an obsequious attendant upon "his royal master," with whom he had entered into an offensive and defensive alliance against the common people.

Steady improvement of the weapon through the seventeenth and eighteenth centuries, by the men who were wielding it to gain for themselves the commonest rights of ownership in their own souls and bodies and the fruits of their toil, had made the musket so handy that the cumbrous fork-rest could be dispensed with, and had given it the flint-lock, the bayonet, and the front-sight, which latter greatly increased the accuracy of aim.

By another of those remarkable providential dispensations, grim old Leopold of Dessau devised the iron ramrod, just at the time when it was most needed to enable the little Prussian army to withstand the overwhelming masses of barbaric Russia, stupid old Austria, and intriguing France. As Frederick II's men were able to fire five times to their enemies' twice, the reactionary waves beat in vain against the new bulwark raised up to protect the progressivism which had made its home in Northwestern Europe.

Across the Western seas a still greater development was taking place. In the grasp of the men who had sought refuge from tyranny in the wilds of America the musket was not the mysterious and awkwardly handled engine it was in the hands of most Europeans. To the colonist it was the most familiar of his every-day tools. The daily food of the family was provided with it; the fiercest wild beasts were slain by it, and the fiercer wild Indians were conquered by it and driven from the lands which they claimed as their birthright. Being its owner's main dependence in his struggle for life, he naturally strove to raise its powers to the highest mechanical limits of the day. By rifling the inside of the barrel, and placing a sight on the rear end, he made his aim mathematically certain. With such a weapon he could encounter every mortal foe with entire confidence. Rattlesnake nor panther, wild Indian nor foreign mercenary, had any terrors for him. If his foe had brain or heart, his unerring bullet was sure to find it.

With his rifle in hand the common man reclothed himself with all the rights that had been torn from him by a thousand years of the despotism of the Man on Horseback. He brooked so little of tyranny that he would not endure so much of it as was involved in the attempt to tax him without his full consent. The assertion in the preamble to the Declaration of Independence differed from most similar fulminations in that it was not ahead but only abreast of the popular acceptance of the principles which it affirmed. Men were not only endowed with the inalienable rights of life, liberty, and the pursuit of happiness, but on this side of the ocean they exercised them to the fullest extent.

Still more : they taught the Frenchmen who had come here to assist them in their final struggle for freedom, by precept, and those who had stayed at home by example, that the musket was the means by which those rights were obtained and maintained. They demonstrated in practice the axioms to a perception of which all Europe had been slowly rising : that before the musket's muzzle all men are equal ; that lordly lineage, boundless wealth, nor privileged caste can hedge a man with a divinity impervious to bullets ; but that any set of men, who love liberty well enough to peril life for it, must be met on equal terms, with equal hazard of life, by those who would deprive them of it ; that the reign of the few was ending, and that of the many beginning, for, with all men equally able to kill their opposers, only those governments and systems of governments can maintain themselves which can rally to their support more than can be arrayed in opposition.

In all the world's history no teaching ever had such immediate and tremendous results. Within a quarter of a century after the close of the American Revolution the new Evangel of Freedom had flamed from the Seine to the Moskwa, at the muzzles of millions of muskets, borne by men who had suddenly risen from the abasement of serfdom to the full stature of manhood. In France, the chosen home of chivalry, the degenerate sons of the Men on Horseback had been drowned in a sea of their own vicious blood. In all the fairest parts of Continental Europe the land had been wrested from the heirs of the banditti-lords, and restored to the ownership of those who tilled it. The whole civilized world had begun that rapid march toward popular government

> " . . . whose compulsive course
> Ne'er knows retiring ebb,"

but will "keep due on," until emperors, kings, and potentates will be as obsolete as the "tabards," "beevors," "brassards," and other trumpery of the mediæval Man on Horseback.

All life is battling—all society a conflict of forces. Little worth having is ever got without being wrung from the teeth of opposition. Particularly is this true of the ordinary possession of manhood. Every privilege and immunity which we enjoy to-day, without more thought than we enjoy the sunshine and the summer air, has been extorted—most frequently through bloodshed—from those who would fain withhold it. The student of history reading the Bill of Rights sees in every clause the result of some successful war fought to wring a concession of that particular principle from the dominant class. The musket has steadily led the way and supported every extension of the boundaries of freedom. Without so irresistible a weapon within reach of every man's hand, the world would still be prostrate under the hoofs of an equestrian aristocracy, whose despotism would only be tempered by the tyranny of kingcraft.

Artillery is monarchic, cavalry aristocratic, and infantry democratic. Armor and the horse brought about the rule of the few over the many; cannon helped make one man ruler over all; while the musket is the agent of the popular will and the pioneer of universal suffrage. "All free government," says an eminent philosopher, "depends upon the power of the majority to whip the minority." The fundamental principle of democracy is that the wishes of one thousand men shall prevail over those of nine hundred men, and the musket gives the thousand men the physical power to enforce their will upon the nine hundred men.

DISCRIMINATION IN RAILWAY RATES.

By GERRIT L. LANSING.

I.

THE term discrimination, in its application to railroad rates, seems in the minds of some to have lost its original and true meaning—the act of distinguishing between things which are different. In the general affairs of life, the ability to discriminate is as commendable as the lack of it is discreditable. There appears no reason why the reverse of this should be true when applied to transportation. There must always be differences which fairly affect rates, as competitive routes and markets, the bulk and value of commodities, and the volume of the traffic. These differences demand recognition and require discrimination in fixing rates; but there should be no discrimination without a difference. This would afford a profit to a favored few, but would effect an injury to the many, and is therefore unjust.

It is asserted by transportation companies that such discriminations as they practice result from the differences which exist, and, though they may sometimes cause an injury to a few, they effect a much greater benefit to the many. The difficulty in the question is right here: The decision as to what is a sufficient difference to fairly require a discrimination in its favor must be decided by the fallible mind of man. Differences of interest and so of opinion are therefore more frequent than differences of traffic. We may readily believe their statement, that the railroad managers are constantly besieged by the representatives of various places, trades, occupations, and interests, asking for concessions in rates that are not granted to others. Each claims some peculiarity of situation or circumstance which justifies some concession. It is natural also that most of these claims should be based on interest rather than on principle. The railroad manager is prone to this view, as the interests of the property under his charge are certainly not advanced by building up the trade of one place or person by giving lower rates than are allowed to others similarly situated. These differences of opinion, it seems, must always continue to exist as long as there are different interests in commerce and different circumstances affecting production and trade. The decision as to the differences, too, must always be made by man; and the government official in Germany, France, Italy, Spain, and other countries of Europe where there is state ownership of railroads, has caused even more complaint by his rulings than has the manager of the private corporation in the United States.

That discrimination may be fairly and legally exercised has been decided by the courts, while most of the States prohibit unjust discrimination. An act of the Legislature of Illinois of July 1, 1871, "was pronounced unconstitutional by the Supreme Court of the State, because in its operations it was not in express terms directed against *unjust* discrimination, but against discrimination generally." *

Such discriminations in rates as result from the operation of the railroads under the control only of the requirements of commerce and the interest of the corporations can not be unjust in the sense of political economy, can not affect injuriously the interests of the community at large, but, on the other hand, must always work for the advancement of the common good.

The causes of discrimination will be found in the principles regulating rates. That there are some natural principles is shown from the fact that in all the different parts of the world where railroads have been built the same questions arise from the dissatisfaction of communities, interests, and trades; the same charges of unjust discrimination are made, and the same remedies have been applied of legislative restriction and interference. To this we may add that there has been everywhere the same failure of these remedies to effect the result de-

* "Report of Railroad Commissioners of Illinois," 1876, p. 17.

sired. In the older localities the earlier rule of interference has been gradually withdrawn, as the common commercial law of self-interest has been found to produce the best results; and as the populations of newer communities have increased, their interests have become more established, and their experiences enlarged, they too tend toward the path followed by the older places. Italy, after an examination of the subject by a special commission, which was continued several years, decided to lease the Government railways to private corporations to operate. Switzerland, upon reviewing the experience of the other states of Europe, declined to exercise the right granted by the charters of the railway companies, that after a certain time the Government might purchase and operate the roads, deciding that it would neither profit the state nor benefit the people.* M. Léon Say says of the Government operation of the railways of France, "The failure is complete and irreparable." † And M. de la Gournerie, Inspector-General of the French Corps of Bridges and Highways, concludes a review of the subject of railway rates as follows: "I have sought to combat the widely spread opinion that, in the commercial operation of railroads, everything is artificial; that instead of observing, we must invent; that instead of habitually leaving the different interests to react upon each other through supply and demand, it is necessary to be regulating continually. If we were certain that the men who manage railroad business would always have a perfect understanding of these questions, my conclusion would be to leave the matter to them entirely; but the companies enjoy too great power for us to resign ourselves to endure tranquilly the consequences of their errors. I think, then, that the state should preserve its powers, watch attentively, but prescribe little." ‡ The other countries of Europe have in general gone through similar experiences and arrived at the same conclusions, and, following the enlightened lead of the Railroad Commission of Massachusetts, the tendency in the other States of the American Union is undeniable also in the same direction of *laissez faire*.

In the transaction of trade, exchange is effected, not because one party demands it, but because both believe it to be a benefit. Neither can command what the other considers it his interest to refuse. Transportation is limited in the same way by the same requirements. The limit on one side is fixed by capital and is the *total cost of all the service performed*. If the roads are not able to secure enough traffic at prices which will pay the expenses of operation and a fair rate of interest on the investment, capital will no longer be invested in their construction. If they persistently fail to earn the ordinary expenses of operation, and so remain a constant tax upon the proprietors, they must ultimately be abandoned. The reduction of the charges can not

* "Herapath's Journal," London, April 28, 1883, p. 518.

† "Railway Age," 1882, p. 735.

‡ "Report of Commissioners of Transportation," California, 1877–'78, p. 73.

permanently be so low that the income is less than the expenditure. *The value of the service* to the shipper fixes the opposite limit to the reduction of charges. Here the rule applies to each shipment and at once. The shipper knows with considerable exactness the elements which enter into the cost of the commodity and the price it will bring in the market. He can at once determine then whether or not its transportation will afford him a profit. If it will, it is sent. If not, it remains where it is. With the railroad, on the other hand, the cost of no single shipment can be determined. It is carried on a freight-train, which also carries many other shipments consigned to many places. The same train often carries emigrant passengers, and is run over a track which is also used by passenger-trains. Besides these elements, there are large expenses incurred by the company of which an indefinite amount is chargeable to the various classes of traffic performed. It is thus a matter of impossibility to say what will be the cost of any particular shipment, and it is even a matter of extreme uncertainty to state the cost of the various classes of traffic each by itself—as passengers, freight, express, or mails. The only course then left to the railroad is to take the freight at whatever rate the shipper can send it with profit to himself and hope the whole of its traffic will amount to a greater sum than the cost of the service. The railroad may thus for years continue carrying freight at rates which do not cover the cost of the service, while the shipper will immediately stop his freight as soon as its transportation ceases to be remunerative to him. The rates can in no case be more than the value of the service, but they may be less than its cost. Between these two limits, the former of which ultimately determines the point below which no rates will be held, and the latter of which immediately determines the point above which no freight will be sent, there is in practical operation a varying scale of rates determined by competition both of parallel lines and various commercial forces.

These different kinds of competition I have elsewhere dwelt upon ;* it will answer the present purpose to name them. They are : competition of capital, of parallel railroads and water-routes, of markets, and the efforts of the railroad to increase its net income by increasing its traffic with lower rates. Wherever there is a fair discrimination exercised in fixing rates, it will be found to be based on one or more of these forms of competition. This proposition, it is intended to illustrate in the following pages ; and, if true, it is of the first importance, for, as competition is generally conceded to be a more potent regulator of prices than all other forces, if discriminations result from it, to prohibit them must also interfere with competition. All forms of discrimination in the rates of transportation which are fairly exercised may be classed under three heads—namely, those which favor persons, places, or things.

* "North American Review," May, 1884.

1. Persons.—Discriminations which are exercised in favor of persons in the transportation of freight will be found to be not in favor of the person but of the freight. In fact, personality has no part in it, but the concession is caused by the circumstances of locality or the kind or volume of the traffic. For instance, the farmers of the West and Northwest are systematically and greatly favored in the shipment of their products to the market. Grain and provisions are carried from Chicago to the seaboard at a discrimination in their favor of at least three to one as compared with the shipments by merchants, manufacturers, and others. But as without this concession the farmer would have no market for the greater part of his crop, and as it cheapens the cost to consumers of the staff of life, it is, though a discrimination, a subject of no complaint. The same remark applies to dealers in coal, lumber, petroleum, and all other things produced and consumed in large quantities.

But such rates should be open to all under similar circumstances; they can not fairly be affected by the personality. Where the circumstances of situation, kind, and quantity are the same, to give lower rates to one person than to another is, in most States, illegal as well as unjust. It tends, by preventing competition in trade, to maintain prices, and so to limit consumption and restrict traffic—a result directly opposed to the chief end for which all railroad managers are striving. I can conceive of no case in which a railroad would grant one shipper privileges not accorded to another where the circumstances of the traffic were the same, except it were as a gift and not in the line of a business policy; that is to say, the advantage given would be at the expense of the railroad.

In the transportation of passengers, however, differential rates are made which more nearly approach a discrimination as to persons. Yet, in this case too we will find that the different rates are caused by a difference in the traffic, and that, under like circumstances, rates to all are alike. With passengers, a discrimination based on the volume of the traffic results in the excursion rates, round-trip tickets, commutation, season, and one thousand-mile tickets, and the like, familiar to all. For instance, in California, from San Francisco to Alameda, Oakland, or Berkeley, a distance in each case of about ten miles, the passenger may buy a trip-ticket for fifteen cents, a round-trip ticket for twenty-five cents, and a sixty-ride ticket for three dollars, or at the rate of five cents a trip. The rate per mile would be, in the several cases, a cent and a half, a cent and a quarter, and half a cent respectively. Though here is a discrimination, in the proportion of three to one, yet its fairness is not only popularly conceded, but the Constitution of the State especially provides that "excursion and commutation tickets may be issued at special rates." The question, as popularly put, here arises, "On the ground of fairness, why should one person in the same train, between the same points, pay three times as much fare as another?" The highest of these fares—a cent and a half a mile—is much lower than the average rate of fare charged in the United States or on the remaining portions of the same road. It is certainly not, then, unreasonably high. But the reason it is lower than in the average of cases is that the ordinary traffic between the points in question, excluding that at special rates, and the possibilities of its development, are sufficient to warrant it. As to the traffic carried at the special rates, it could not be obtained without the special concessions. And, the road being built and the trains running, the *extra* traffic may be carried at a fraction of the average rate of cost for the *whole*. There is thus a profit under the circumstances on this traffic at the special rates; and, as it is developed and increased by the concessions made in its favor, it helps to pay more and more of the fixed expenses which were in force before its existence, and so by relieving the regular traffic of a portion of its burden of expense makes possible also a reduction in its rates. The reason for the discrimination, then, results from its necessity to secure the traffic; the common reason in all cases of lawful and fair discrimination. If, by an equalization of these rates, their averages were established as the rate for the whole, the daily passenger who now pays ten cents a day for his fare from his home to his place of business in the city and return would then be compelled to pay twenty-two cents. It is certain that in the greater number of cases he would not do this. Now, with this suburban traffic, as with all other traffic, the rates decrease as the volume increases—other things being equal—and, as the rate of expenses per passenger also decreases under the same conditions, the differential rates are justified on the ground of the cost of the service, as well as from the necessity of the traffic. The very much greater portion of the suburban traffic is from the passengers who travel daily, a much smaller portion from those who purchase round-trip tickets, and the remainder from those who make an occasional single trip. The rates are thus inversely to the volume of the traffic. The highest *rate* is paid by those who pay very few *fares*, and the lowest by those who pay the largest number. This is a distribution of the burden of the expense which causes it to be felt the least; and it results in giving the benefit in the fares to those who by increasing the traffic cause the reduction in the rate of expense.

That the suburban passenger traffic throughout the United States is carried at lower rates than any other is a familiar fact, explained by the possibility of development and justified by its much greater volume, which is accompanied by a lower rate of cost per passenger. Where the volume of the traffic is less, the rate and the cost per passenger are alike greater. This rule holds good throughout, other things of course being equal. In the minority report of the Railroad Commission of California for 1883 (pp. 137–140), which is extremely hostile to the railroads of that State, it appears that the lowest passenger rates exist where there is the greatest traffic, and that "between all the thickly settled portions of the State" the rates are considerably lower than prescribed by the orders of the commissioners. An appended table in the same report shows that during the year 1881 the principal railroad company in the State had forty-six stations from which no passengers were carried, sixty-two from which the daily average was from one passenger each two days to one in thirty days, and there were forty stations to which no tickets were sold. It is in these cases, the report explains, that the highest rates prevail.

It thus appears that the discriminations which may be fairly exercised as to persons are not affected by the personality, but by the traffic. Like rates under like circumstances to all is certainly the common rule in experience, and in nearly every State any violation of this is properly prohibited by law. The railroad takes no cognizance of the person, but exerts all its efforts toward developing the traffic. The passenger who pays a cent and a half per mile for a single-trip ticket may, if he chooses, buy a sixty-ride ticket at one third that rate. The possibility of development depends upon population; it is greatest between great cities and their suburbs, and least in the sparsely settled plains and mountains of the West.

The discriminations which are popularly supposed to favor persons in the transportation of freight, it will appear, are in a similar way caused by the traffic, and not by the person. Some of these depend on the difference between things, the remainder upon the differences in the situation of places.

2. Things.—There are some discriminations between things, the justice of which will at once be recognized, as there is an obvious difference between them. Light and bulky articles occupying an unusual amount of space should, if charged by weight, be charged at a higher rate than more compact things; fragile articles involve a greater loss to the railroad from breakage, which entails a greater average cost in their transportation; and valuable commodities being more frequently stolen, and as frequently lost, entail an extra rate to cover the insurance while in transit which is assumed by the carrier. But, aside from these obvious differences of bulk and value, which justify a difference in rates, there are other discriminations between things which will be found to be chiefly based on the volume of the traffic and the possibility of its development.

On examination we will find that the discrimination in these cases also is justified by a difference in the cost of the service. Large quantities are moved at a lower rate of cost per ton per mile than are smaller quantities. A car fully loaded to one consignee is carried at a great advantage over the same car partially loaded with small shipments to various persons; and train-loads running through with grain or coal, it will readily be seen, may be carried and handled at a lower rate per ton per mile than shipments aggregating an equal tonnage switched off at various points and consigned to various parties. The Commissioners of Railroads of Massachusetts, in considering a complaint which was made on this ground of discrimination, not only justify the principle of quantity in reducing rates, but affirm that any other rule would be unjust. "One fact exists," they say, in reviewing a case, "which furnishes strong ground for criticism on the rates which are the subject of complaint. The Boston and Albany does not establish a lower rate for cargoes or large quantities than those fixed for car-loads. . . . The other great roads of the State do have one rate for car-loads and another and lower rate for cargoes, or for some large amount, generally fixed at one hundred tons. The principle on which this difference rests is founded on common sense, and is well recognized in railroad law; and it is recognized by the managers of the Boston and Albany Railroad in some other branches of traffic. Wholesale transactions furnish a reasonable ground for a reduction of rates; and, as the car-load rates of the Boston and Albany must be held as against that company to be reasonable as car-load rates, it follows that as cargo rates they are unreasonable." * This opinion is affirmed by the same company in their report for the year following, when in referring to the first case they say, "The meaning of the opinion was, that it was reasonable to fix a lower rate for large quantities than for single car-loads." † The principle here applied to cargoes and car-loads is generally applied to car-loads as compared to smaller quantities, and as the "car-load rate," though lower than the rate for smaller quantities, has been generally approved, it amounts also to an approval of the principle of lower rates for larger quantities.

The difference in rates on the same thing justified in the difference in quantity is generally charged by those shipping in small quantities to be a discrimination against them as individuals, and so as unjust. But we find a denial of this in the fact that the rule affects more frequently *things* which are shipped in large quantities than *persons* who ship large quantities of the same thing. Grain, provisions, and coal usually form the largest items of tonnage and have the lowest rates, and it is in favor of these things that the greatest discriminations are made. To deny the fairness of the principle would require not only that the various quantities should all take the same rate, but that things themselves should take the rates charged on other similar things which are shipped in smaller quantity. This is a result which some newspapers and politicians imagine would be beneficial; for instance, I read in a daily paper that it is an "outrage" that wheat is carried from the interior to San Francisco at a lower rate than castor-beans. But it is a result which, in the opinion of the Railroad Commissioners of Massachusetts, "would work mischief in some sections, would divert business from the State, paralyze industry, drive away capital, and injure our great interest—labor." ‡

* "Report," 1881, p. 212. † "Report," 1882, p. 100. ‡ "Report," 1883, p. 26.

The effect of free competition in trade is to bring the greatest competition to bear on those things in which there is the greatest trade. Thus, there is the smallest margin of profit over the cost of production on the necessaries of life, the next smallest on the common comforts, and the largest on the luxuries. This effect is not caused by any design on the part of traders nor from any beneficent legislation on the part of politicians. It results from the operation of natural laws of trade. The operations of the same laws produce the same effect on the rates of transportation. We find, as a rule, the lowest rates on coal, wood, petroleum, iron, lumber, etc.; the next lowest on flour, grain, provisions, etc.; we then have boots and shoes, cotton and woolen goods, clothing, etc.; and then a varying list of more costly or perishable articles and luxuries which are consumed in decreasing quantities. All the natural forces of competition which tend to reduce the rates of transportation co-operate in producing this discrimination in things which are moved in the largest quantities, and which are, of course, consumed in the largest amounts. The aim of the railroad manager is to secure the traffic. To do this he must make lower rates on cheap commodities, with those things which comprise the necessaries of life. It results in distributing the charges for transportation where they are most easily borne. Not only do the necessaries have the lowest rates and the luxuries the highest, but the necessaries consumed in the largest quantities have lower rates than those consumed in smaller quantities. We consume more fuel than bread, and more food than clothing, while the rates of transportation follow the opposite order.

This discrimination, though in favor of the necessaries and common comforts of life, is none the less a discrimination. It actually results in favoring classes. Those who consume but the necessaries, the day-laborers, are the most benefited; the artisans who consume, in addition to the necessaries, many of the comforts, the next; and so on as higher wages provide more of the comforts, and these merge into the luxuries. But the objection is frequently raised that the things having the lower rates are favored *at the expense of* the things required to pay the higher rates. That articles at low rates should be carried at the expense of things charged higher rates implies of necessity that the lower rates are below the cost, that the service is performed by the railroad at a loss. If the low-rate traffic is not carried at a loss—if the profit be ever so small—it can not, of course, be at the expense of the things paying higher rates. That the railroad should knowingly perform any part of its service at a loss is an absurdity, unless it be a case of nourishing an infant industry, where a temporary loss is incurred to secure a future gain. Those, indeed, who have been most forward in charging upon the railroads the fault of carrying part of their traffic at the expense of another part, would be the last to assert that the railroads are in the habit of doing a considerable part of their service below cost. This charge is so frequently made, and the facts are so commonly misunderstood, that the subject deserves to be followed further.

We are for the present considering only the discrimination between *things* as determining the rate of their transportation. Discriminations from other causes do not change this result. Competition by other lines between the same points, or to the same market, produces a general reduction in rates, but there remains the same inequality in the particular things shipped. The lowest rates will be given on the staple products of the country which are moved in the largest quantities and higher rates on merchandise shipped in smaller consignments. For instance, the chief products of the West—grain, provisions, and flour—are shipped to the seaboard for about one half the rate charged on miscellaneous merchandise. And this is the same, whether the route be by lake, canal, or any of the various lines of rail.

One of the natural principles of regulating rates which has been mentioned is the power possessed by the railroad of increasing its net income by increasing its traffic at lower rates. This follows from the fact that a large portion of the expenses are fixed—are not changed by the increase or decrease of traffic; so that an augmented traffic adds to but a portion of the expenses of the roads—to those not fixed. The average rate of cost per ton per mile thus decreases, other things equal, as the traffic increases. This result will appear more definite by the use of figures. The census for 1880 * shows that the annual interest, maintenance, and operation charges paid at that time by the railroads of the United States, amounted to about the sum of $542,000,000, classified as follows:

	Amount.	Per cent.
1. Interest paid on debt †	$187,250,826	34·6
2. General officers, legal expenses, taxes, etc.	59,541,684	11·0
3. Maintenance of bridges, buildings, and way.	85,722,748	15·8
4. Maintenance of engines and cars	54,985,340	10·1
5. Conducting transportation	88,230,621	16·3
6. Motive power—fuel, engine-men, etc	66,219,576	12·2
Total charges paid	$541,950,795	100·0

It appears from these figures that the fixed expenses of the average railroad in the United States, which are a necessary charge on whatever traffic is carried, are:

1. Interest	34·6 per cent.
2. General expenses, taxes, etc.	11·0 " "
3. Maintenance of way	15·8 " "
4. A portion of the maintenance of rolling-stock, which, if we assume to be one half, will be	5·05 " "
Making a total of	66.45 " "

* Vol. IV, "Transportation.'

† By adding dividends paid, the item of interest would be considerably increased, giving a larger percentage to the fixed expenses and a smaller to be affected by traffic; but,

On the other hand, we have the remaining items which are directly affected by and vary with the particular kind or quantity of the traffic, namely:

Conducting transportation	16·3 per cent.
Motive power	12·2 " "
And say one half maintenance of rolling-stock	5 05 " "
Making a total of	33·55 " "

We may say in very general terms, but which are sufficiently accurate to illustrate the principle, that 66·45, or say two thirds, of the expenses of the railroad are unaffected, or affected in a slight degree, by the quantity of the traffic. With one train or ten trains a day two thirds of the expenses would remain without great change. By the increase of traffic the remaining one third of the expenses would be increased, though still not in proportion to the increase of traffic—as it costs no more for the wages of train-men, for instance, whether the cars are half-empty or all loaded to their full capacity.

An established traffic, then, which at the rate of one cent per ton per mile would pay all expenses, including interest on the investment, might be increased in volume with an increased cost of but one third of one cent per ton per mile. All in excess of that sum would be a profit to the company. So a lower class of freight at a rate of one half a cent, instead of being carried at a loss, or at the expense of the originally established traffic, would not only pay the additional expense incurred in its transportation of one third of a cent, but a profit also of one sixth of a cent per ton per mile. This small rate of profit multiplied by many tons may become a greater sum than the higher rate applied to its smaller tonnage. So it comes to pay a great part of the fixed expenses, and by relieving the higher-rate traffic of a portion of that burden allows reductions in the rates charged on that traffic which theretofore were not possible. The process continues indefinitely. Traffic formerly at higher rates is then stimulated by lower rates, with the hope of increasing its volume, and so of the net amount of profit in its carriage. New industries become possible where the former cost of the service on the movement of their products precluded their transportation. The principle which in the commencement led to a discrimination in favor of certain staple commodities, in the end results in reducing the rates on nearly or quite all articles composing the traffic.

The proposition, therefore, that the transportation of things at lower rates is carried at the expense of things at higher rates, though fair in sound, is false in fact. The error is in the assumption that all traffic is alike, that it is the same kind, quantity, and value. Remove these elements, and the proposition becomes a truism. Remove them, too, and the discrimination disappears. Or, if not, there being no dif-

as these figures are at best but approximate, the principle of the illustration is not affected, whether any item is either more or less.

ference in the traffic, the discrimination becomes then unjust. The fallacy of the proposition seems not to have been discovered by many who have been prominent in discussing the question of the regulation of railroad rates. I mean those who have taken a political rather than an economic view of the subject. Following a similar kind of reasoning, they have deduced the unreasonableness of higher rates from the existence of lower rates. "As," they say, "rates on grain, flour, or other things carried at low rates, being voluntarily fixed by the carrier, are presumably fair, it follows that rates not so low are unfair." Here, again, the traffic is conceived of as a mental abstraction which admits of no division or degree; it is always traffic—that is, always the same; while, as a matter of fact, there is a much greater difference in the things than in the discrimination. For, practically, instead of a refined classification, taking into account all differences of value, bulk, quantity, or destructibility, things which are similar in these respects, though not the same, are grouped together in a single class.

The enforcement of uniform rates on all the traffic of a railroad (making a difference only for bulky and perishable articles) is in practice a thing of the past, though with politicians it is still preached. It has, wherever tried, been found not only wanting, but destructive. In Belgium, as most of the railroads were owned and operated by the state, the uniform rate theory was naturally adopted, as upon the face it seemed to be the fairest plan. The effect was the restriction of traffic and the oppression of commerce. After this system had been some time tried, however, the cause of the restriction was seen to be the lack of discrimination in things, basing the rates upon bulk, weight, and destructibility only, and ignoring the fundamental principle—the value of the service.

The result of this experience is thus stated by the Commissioners of Railroads of Massachusetts:

"In 1856, in spite of a considerable increase in the miles of railroad worked, the freight movement of the Belgian railroads was found to have seriously decreased. Instead of making good the deficiency in receipts by increased rates on existing business, the administration met the emergency by accepting all traffic that offered, at greatly reduced special rates. This policy succeeded so well that, in 1861, the principle was adopted as regards minerals and raw materials of a regular low scale of charges, with a reduction according to distance. This resulted in the following year in an increase of 72 per cent in the tonnage of this class of goods. In 1862 the principle was extended to goods of the next class, with similar results. In 1864 freights were reclassified and the new principle applied to all except the first class, or small parcels which in this country are known as express matter. The result was summed up by the Minister of Public Works as follows: 'In eight years, between 1856–'64, the charges on goods have been lowered, on an average, by 28 per cent; the public have sent 2,706,000 tons more goods, while they have actually saved more than $4,000,000 on the cost of carriage, and the public treasury has earned an increased net profit of $1,150,000.' A further reduction, made subsequently to this statement in 1864, exceeded even these results, and under it the tonnage rose from 4,479,000 tons in 1863 to 6,533,000 tons in 1864." *

In this country, an extract from the report of the railroad commisioners of a single State will illustrate the common experience as to the operation of the principle of discrimination in things. The Commissioners of Railroads for Alabama tell us: "A proviso of the first section of the act to provide for the regulation of railroad companies and persons operating railroads in this State, approved February 26, 1881, provides: 'That nothing in this act shall be construed to prevent contracts for special rates for the purpose of developing any industrial enterprises, or to prevent the execution of any such contract now existing.' Whether in pursuance of law, or for the development of their own business, it is usual for such railroad companies to concede such 'special rates' to these 'industrial enterprises' for the purpose of developing and building them up, such as factories, mines, lumber-mills, flouring and grist mills, gas companies, water-works, and other 'industrial enterprises.' These 'industrial enterprises,' as we have stated, have these special rates conceded to them very generally in the different States of the American Union. The products of the labor and skill of these 'industrial enterprises' are in many instances transported to distant markets, and the enterprises themselves are created for the purpose of such competition. Where this is the case, enterprises of this description in Alabama would not enter into this competition with those of other States unless put upon an equal footing with them as is done by these 'special rates'; nor could they maintain their business in competition with those of other States in the absence of such 'special rates.' And where these 'industrial enterprises' do not enter into the competition in other States—many of them do in Alabama—and in the absence of such 'special rates,' they would not be on equal footing to compete even in this State with enterprises of a similar character in other States, but doing business in Alabama. And in this class of these industrial enterprises where this competition does not exist at all, yet they furnish employment to larger numbers of persons, and confer public benefits in business upon the localities where they exist. It will thus be seen that in the two classes of these 'industrial enterprises' first above named, what would seem to be, to those not familiar with the facts, a special immunity given to them in these 'special rates,' and not accorded to the public generally, is, in fact, nothing more than putting them on an equal footing with similar enterprises in other States, and enabling them to fairly compete with

* "Massachusetts Report," 1870-'71, pp. 52, 53.

such foreign enterprises; while, in the third class, the State and community, as a consideration for the privilege allowed, receive a benefit which is general and permanent. Without such 'special rates,' few of these enterprises could be made profitable, and the most of them would have to be abandoned. We state these facts, for such they are, and not for the purpose of entering into any argument or defense of the system. We found such 'special rates' existing between the railroad companies and these 'industrial enterprises' in the State at the time we entered upon our duties, and many have been made between them since that time. We have examined these 'special rates' very generally and particularly. The railroad companies have furnished them to us for this purpose. We think that in general they are such as are well calculated to develop and build up these 'industrial enterprises.' We have examined them for the purpose of ascertaining whether there was in any of them any 'unjust discrimination,' in favor of any and against others of these 'industrial enterprises,' and thus far we have discovered nothing that can be fairly construed to come within this category. These 'special rates' are, of course, as various as the different kinds of business to which they relate. We have notified the railroad companies that, under the statute, they have the right to make any such 'special rates' of this character as may be agreed upon by them and any of these 'industrial enterprises' in favor of one and against another, and they have all uniformly adopted the same view of this matter. They are matters of contract in every instance, and therefore are not in such shape that they can be tabulated in this report."* The number of these pages might be indefinitely increased by additional quotations from the experience of Europe and America, illustrating the beneficial operation of the principle of discrimination between things in determining the rates of transportation. But enough has been said to show that the principle is based upon commercial necessity, and that under the operation of any other rule the railroad would fall far short alike of achieving its greatest usefulness to its patrons, and of yielding the largest profit to its proprietors.

ACCLIMATIZATION.†

By Professor RUDOLPH VIRCHOW.

IT is a well-known fact that the influence of a strange climate upon the emigrant, however little the new medium may differ from the mother-country in more or less essential qualities, exhibits itself at first in a kind of recrudescence of vigor, which, however, in a very

* "Alabama Reports," 1882, p. 28.

† From an address before the Congress of German Naturalists and Physicians, at Strasburg, September 22, 1885.

short time, sometimes after a few days, gives place to a general languor. Days, weeks, or months, according to the degree of healthfulness of the place, may pass before the organism is again in equilibrium; and this fact is so generally recognized that every traveler expects it and prepares for it. A person just landed in a distant country would be chargeable with imprudence if he neglected the precautions which experience has prescribed for diminishing as much as possible the inconveniences of this critical period. What does this mean? Simply that the organization of the new-comer must bring itself into harmony with the new medium. It makes no difference that he finds in the strange climate, in the European hotels, comforts, fare, and attentions so perfect as almost to make him forget that he has ever left his native land; he has, all the same, to go through the change which the climate works in his organism. He must adapt himself to it, become used to the new conditions. The fact of this process going on was known a long time before Darwin came into the world; and there is not, so far as I know, any doctor who has interpreted it in any other way than as a physical modification of the organism which is not limited to some superficial trait acquired by the transplanted person, but notably modifies the mechanism of the vital functions.

Two kinds of effects accompany the course of acclimatization: first, simple discomfort or climatic indisposition; and, afterward, illness proper or climatic illness. Danger, as distinguished from simple inconvenience, is the element that characterizes climatic illness. The invasion of the disease is real only in so far as the existence, or the integrity at least, of the whole organism is threatened. Till this moment, we have only indisposition to deal with; although, to speak accurately, illness and indisposition are not separated by clearly defined limits, but are rather two degrees of intensity of the same manifestation. A person is ill in the evening who was only indisposed in the morning.

If we review the vast literature that has accumulated on this subject, we shall be obliged to confess that original labors respecting these special modifications are almost wholly wanting. On the other hand, as soon as illness appears, the interest, which has now become immediate, excites the ardor of physicians; and they, by their numerous researches in this branch of the subject have given us knowledge, not only of what are generally the diseases of foreign regions, but also of their immediate causes. And, while there are still a few points in dispute, the increasing extension of wisely directed medical studies, at home and abroad, gives a well-founded hope that they will shortly be settled. Otherwise the condition of foreign medicine is but little different from that of our own; and there is no doubt that, with the progress of science, the clinics of tropical maladies will acquire an equally important development.

Our knowledge of the facts relative to climatic indispositions is not what it ought to be, and yet there are some respecting which information is particularly important to us. Inasmuch as a transformation of the organism constitutes the principal element of a durable acclimatization, it is not the individual alone who is affected by a prolonged sojourn away from his native country, but his entire posterity as well. We can not, therefore, deny that this side of the question is the most important of all. There is one point of view from which the study of the transformations acquires a general interest of really vast extent. It is that of their relations with the history of the human race. Two questions occur at once to all who seek to arrive at a clear idea of the manner in which man has reached his present condition. Is it true that the different human races and varieties are issues from a common stock? And what are the causes of their diversity? It is of no use for our friends the zoölogists to preach transformism to us. That may do very well of itself when we have only an affair of building up a system. But, unfortunately, no man has ever yet observed the transformation from one race to another. No one has, for example, seen a people of the white race become black under the tropics, or negroes transplanted to the polar regions or to Canada metamorphosed into whites. The question whether color is related to climate still remains to be solved, experimentally at least; data bearing on the subject are still absolutely wanting. I confess that, if any one should ask me for the slightest light respecting the origin of races, I should not be in a condition to give a plausible argument or an experimental fact that would be competent to justify any point of view whatever. It is nevertheless true that, at the bottom of every impartial study of the phenomena of acclimatization, we arrive inevitably at the old point of view of Hippocrates, and that the existence of a relation between the somatic properties of man and certain geographical circumscriptions is not doubtful. That is what my friend Bastian understands by the term ethnological provinces. The reality of such provinces is incontestable; and they have the same significance with reference to man as zoölogical and botanical provinces in the geographical distribution of plants and animals. We can not deny that we have also the right to premise the existence of general laws of acclimatization which apply to plants and animals as well as to man—at least so far as regards the modifications of classes.

The prime question for us relates to the aptitude which the white man has manifested for acclimatization through all his historical evolution. To what point have we a right to conclude, from the data furnished by history, that the white man can find, outside of the limits of his country, conditions favorable to his existence? To bring up the vital point of the problem at once, the white man is not everywhere the same. Scientific experiment is every day tending to bring into more prominent relief the sharp differences in this matter which exist among the different subdivisions of the white race which we ordinarily include under a common denomination. Between the Aryan and Semitic branches, for example, the contrast is very clear. All the statistical documents and all the observations at large (*grands traits*) that have been made to this day go to confirm the greatly superior power of acclimatization of the Semitic to the Aryan peoples. The latter peoples may also be divided; and it is easy to separate those varieties with different aptitudes into geographical groups. The peoples of the south, the Portuguese, the Spaniards, the Maltese, and the Sicilians, are much superior to those of the north—so much so that the choice of one or another of these elements might be of decisive importance for the success of a colonizing enterprise.

In this may be found the solution of the controversy into which I have been drawn in the course of political debates. The fact is, that the history of the colonization of the Antilles shows us that, in the French and English establishments, the results of colonization have always been disastrous for immigrants from Europe, while in the Spanish colonies the results have been relatively favorable, although not so favorable as my adversaries have wished to make them appear.

These general observations must not, however, be accepted without reservation. They as yet represent only the starting-point of the discussion which it remains for us to bring to bear upon two capital questions. The first of these questions is concerning the opinion, which seems at the outset extremely plausible, that immigration into regions near the tropics, or even under the tropics, is nearly harmless to peoples who are natives of southern latitudes. Nothing is further from being proved, as we may see by referring to the negroes, whom it is very difficult to remove safely from one tropical country to another. The French in Senegal have had sad experience of this fact, and have seen death make terrible ravages among black populations which they had transplanted from their native land.

Another consideration that it is important not to lose sight of is that the farther south we go the more have the Aryan branches been exposed to foreign admixtures. The Maltese race, for example, exhibits a much superior resistance to the Sicilian or the southern Spanish race. We might be tempted to explain this by the insular situation of the former race, and by the character of the climate of its country. In that case the Maltese, transported to the African Continent, for instance, to a considerable distance from the coast, having come out from a climate distinctly insular, might be supposed to feel the change more profoundly than a Spaniard coming from his more continental climate. But nothing of the kind takes place. Algerian statistics establish most positively that the Maltese constantly holds his overwhelming superiority in adaptability over the Spaniard.

So the explanation of the special power of resistance shown by this race can not be based entirely upon an agreement of the climate of its native country with that of the place to which it emigrates.

There must, then, enter into the account some favorable circumstances derived from the mixture of foreign blood which it carries in its veins. This foreign blood is chiefly Semitic. As is well known, the Phœnicians, a people having more than one point of analogy with the maritime powers of our own days, were the first colonizers known in history. The Phœnicians were Semites; and archæological traces of their establishments are still to be found in Malta. They founded Carthage, and covered the Spanish coast with colonies, which probably extended for a considerable distance into the interior of the country. As the latest archæological researches prove, they colonized a good part of Greece. Their influence was so great, and their extension was so wide, that it would have been very strange if they had not contracted in Spain and elsewhere numerous family connections, and thus made their blood participate in the development of the races which have survived them in those countries. In less ancient times, most of the Iberian Peninsula was for hundreds of years in the power of the Arabs, or rather of Moors from Africa. These conquerors, who founded large cities and peopled entire districts, so that the Valencian garden and the valley of Granada still retain their Moorish aspect, who, in short, spread themselves over the whole country, undoubtedly left a numerous posterity behind them. And as the Spanish language is full of Moorish reminiscences, and Arabic words still adorn its vocabulary, how can the nation count the descendants of those Moors who hide their Semitic origin under Spanish names?

The race which now peoples those countries is, therefore, a mixed one; and there is no nation, even to us Germans, that has not furnished its quota to it. The Visigoths passed through Spain. They were dissolved there, and so completely absorbed that not a vestige of them is left, except, perhaps, in the institutions in which the most eminent Spaniards acknowledge, not without a feeling of gratitude, the contribution of Germanic genius to the development of their nation. Thus, from this fusion of Iberians, Phœnicians, Moors, Romans, Celts, and Visigoths, to which may be added, perhaps, a few other German elements, such as the Alani, has risen the modern Spanish people, a mixed people, in the elements of which the pure Aryan race enters in part, but is nowise preponderant. If, now, we should undertake to say, "Wherever a Spaniard can go I can go too, for the same blood flows in the veins of both of us," we should be in great error. No; Spanish blood is not the same as flows in our veins; no more than is the blood of the Hindoos of to-day, with whom we have but lately tried to make a common ancestry, but whom no one now regards as a primitive race. We now trace our affiliation to that people which, coming down from the north, was crossed, higher classes and all, with the people that occupied the peninsula long before the arrival of the conquerors, and who were black.

There are, then, mixed races, to a certain extent more mixed than we can observe among ourselves. It is, nevertheless, indisputable that, compared with the races in which the Aryan element has been observed in its purity, those races, especially those which have drawn largely from the Semitic fountain, are incomparably more fitted to acclimatize themselves, and propagate themselves in the midst of the new conditions in which they are placed in hot countries. In order to include under a more characteristic denomination those races which are only slightly refractory to the morbid influences of the climate, races to which we ourselves belong, I proposed, on a former occasion, to call them vulnerable races. This figurative expression might serve, in the domain of pathological ethnology, to designate the property which those races have of going through grave alterations under the influence of relatively slight external causes ; and, considered in the narrower domain of acclimatization, the facility with which, among them, indisposition puts on the aspect of real illness. There is, however, a very limited zone within which these vulnerable races can implant and propagate themselves with comparative security. North America holds the first place in this favorable zone. Here we see the curious phenomenon of the French in Canada, the same northern French who are melting like wax in the sun of Algeria, becoming, from the little colony which they were in the beginning of the century, a vigorous and numerous people, and lively enough to hold their own against the rising tide of English immigration ; while tens and tens of thousands of our countrymen, whom America receives annually at her ports, disappear in a very short time. In Canada, the colonists of French origin, animated by the most lively spirit of independence, have constituted themselves a people apart, and the last conflict, which has just closed, is a convincing proof of the tenacity of their national feeling.

Then comes the United States, with its vigorous and constantly increasing population. However much it may be mixed, it will always be Aryan at the bottom, for all the heterogeneous elements are absorbed, almost without leaving traces of themselves, in that immense hearth of colonization, which has no parallel in history. The English have been no less happy in the settlement of Australia, a colonization the energetic expansion of which has not been checked except toward the north, where the conditions grow unfavorable as the settlements approach the equator. Hence it comes that, in the northern part of Queensland, European colonists are not in a condition to endure the fatigue of agricultural labor. This fact has had much to do with the efforts made of late years to annex New Guinea and New Britain, whence it has been proposed to draw the manual forces required for the tillage of the soil.

In the South African colonies the Dutch have been solidly established for some two hundred years ; and, in a few countries of South America, colonies composed of peoples of various European origin have prospered, though unequally. There are also some young colonies founded by Germans on the Rio Grande, in Brazil, which a fancy still needing confirmation has placed in the rank of healthful countries and suitable for our people. Reviewing the results that have been obtained in the colonies thus briefly enumerated, which embrace the sum of the more or less fortunate enterprises of the kind, we see that their success has been in inverse proportion to the difference in isothermic latitude between them and the mother-country of the colonists. But in every case it is not probable that the organization of the colonists has escaped having to pay, at the expense of profound alterations, for acclimatization in foreign countries. Men of science, as well as tourists, have been interested for many years in the study of the Yankee type, which, according to the general opinion, is not wholly comparable either with the English or the German, or with a cross of the two with the Irish race. The peculiar physiology of the Yankee is yet to be made out, and I can not insist too strongly on the great value of the scientific results that might accrue from the study of this delicate ethnological problem. It is averred that the transformations of this type grow more pronounced as we go from the Northern to the Southern States.

It sometimes occurs that a population transplanted into a distant country remains apparently stationary. Nothing seems to distinguish it from the compatriots which it has left in its native country. But, on regarding it more closely, we find that there is operating within it one of the gravest phenomena in the history of colonization—a phenomenon which has been long observed in animals and plants when transported to new climates: a decrease of fecundity and an arrest of development, going at length to the complete elimination of posterity. It is evident that the condition most essential to the prosperity of a colony, the only guarantee of its longevity, resides in the number of children in the families of the settlers; children who, in their turn, the source of posterity, lead, as at home, to the branching out of every family into numerous ramifications. The further we advance into exotic climates, the more rapidly does the diminution of the reproductive faculty of the colonist go on, the more do statistics indicate a reduction in the number of births and an increasing sterility in successive generations. This fact has been noticed not only by doctors, who have called attention to it from time immemorial, but persons also who could have no prejudice in the matter—statesmen, military men, literary men, and men of every profession and every country, and those who lived in times when the question had not yet begun to be the order of the day—have observed for the most diverse countries that families formerly fertile, but who contracted alliances exclusively with natives of the exotic countries, lasted only a few generations.

It has never been possible, even to this day, to establish a durable colonization in British India. It has, indeed, been said recently that it is possible, by means of severe hygienic processes, successfully to bring up an English generation there; but to do this the children have, as soon as they are able to support the journey, say at five or six years of age, to be taken to the mountains and left there till they are fifteen or sixteen years old. This reminds me of the palm-trees which we succeed in making bear fruit in our gardens. Because, by the use of the most elaborate horticulture we can occasionally cause a plant of the most delicate species to mature its fruit, shall we venture to regard the palm-tree as acclimated in our country? No more can we assert as much of a population which has no chance of maintaining itself except by taking all its children to the mountains and not allowing them to come down thence till they are mature men. A curious kind of family life that, and extremely costly if it were undertaken, the results of which are limited to bringing down the young generation, which is destined to live in the country, from the north to the south, from the mountains to the plain, like the ancient kings of Persia. But the indefatigable perseverance which has been applied for years in organizing this system does not in any way look to the colonization of India. It only seeks to create a new higher class, an aristocracy, which shall be better qualified to govern the country than annual new arrivals from England. I will also observe that the Dutch in Java and their other Eastern establishments have not advanced the problem a step. Every considerable family endeavors to send its children as soon as possible not merely to the mountains, but to Europe, more for physical conservation than for education. As a whole, these attempts at colonization singularly remind us of the fate of the Lombards in Italy. Those people, it is true, survived a little longer on the conquered territory; but very few centuries were sufficient to reduce them to the state of hardly appreciable vestiges. And for the Goths, it did not require a hundred years to annihilate them completely in that same Italy. Minute statistical researches have, it is true, quite recently brought to light here and there a few traces of the Lombards, and it is in a similar way not improbable that there may still exist in the country a very little of the ancient Germanic blood; but in upper Italy there does not remain any well-defined posterity; and in the northern provinces of Portugal and Spain, where the Visigoths reigned in all their power, it would be just as useless to look for any clearly appreciable posterity of the conquerors. I was recently accused of not being willing to range Italy and Spain among the countries favorable to the settlement of families originating in the lands of the North. I am sorry for it, but I can not perceive any facts that make it probable that our countrymen can settle in those states with any expectation of leaving an enduring posterity. I am ready to bow to the proof when it is brought forward. I would also suggest to our physicians of the navy and the merchant marine, and to all who travel for any purpose, that it would be a profitable task to prepare in the most scientific form, and the one most fitted to aid investigations, the existing data bearing on this point.

What, then, to be precise, is the evil which threatens colonial populations, at first sight so little different from our own, and of which no external sign is apparent to reveal very profound transformations? The most powerful agent in producing degeneration, and to which doctors always give the first place, is the reduction of the formation of the blood in the organism. Is there really a retardation of this function, or an exaggerated destruction of the blood? I can not take the responsibility of deciding. Whatever it may be, emigrants are attacked with the same affection as in its phase of complete development among us is called anæmia. The more existence is tried by debilitating influences, the more intense becomes tropical anæmia.

But important as is its part, these debilitating influences do not consist of malaria alone, with its accompaniments of intermittent and other pernicious fevers, dysenteries, and liver-complaints; for even those whom the fever spares are not protected from tropical anæmia. The microscope has revealed to us many other morbid agents. Worms swarm in the tropics, particularly in the water, from which they pass to the body of man; and some of them abide in the blood. All such parasites may become destructive agents to the economy, which is subjected to a decline, the first manifestation of which is always impoverishment of the blood. With all our knowledge of the physiology of the blood, we are not yet able to explain, on the ground of merely theoretical data, the enormous loss of that liquid. We may admit that the preponderant part belongs to the destruction of the blood, while the absorption of air and oxygen is not increased.

A remarkable symptom, which is very well explained by an active destruction of the blood, is the strong predisposition to liver-disease. The liver is an organ the relation of which with the physiology of the blood is very intimate, and the troubles of which have the most influence upon the constitution of that liquid; and that is the organ which is the first object of the attacks, not only of malaria, but of the common diseases of acclimatization.

If I linger on these examples, it is to render more moving and more convincing the appeal which I make to doctors and naturalists to apply themselves to this sphere of research. Neither the French nor the English have as yet done anything important with reference to it. It is, then, a virgin field that falls to German science. It is also a subject of the highest importance; for we can not think of even an approximative solution of the problem till we have gained a precise idea of the modifications of the organism, and particularly of the special alterations of each organ, which are connected with the phenomena of acclimatization.

The popular masses, in their carelessness, seek the acquisition of gold. Show it to them, and they will plunge into perils without concerning themselves about the rules of acclimatization and its diseases, any more than a starving man asks about the sanitary qualities of a ham that is offered to him.

The question before us is not of an isolated enterprise, but of very extensive ones, and is of interest to the empire as well as to the great companies which are lending their aid to emigration. Great problems must be resolved, in order that we may in the future be in a situation to inform our colonists respecting the fate which awaits them, to found colonies with a foresight of what the probable results will be, and to send emigrants into distant countries under the choice of circumstances which will permit them to hope for an assured existence.

These are questions which no general, war minister, or statesman has a right to evade. Why should it be different with those at whose invitation battalions of emigrants leave their country? There is New Guinea, with its rich plains and immense forests coming down to the river-banks. It is no longer a question of sending there only specialists to discover the most profitable timber-trees and then found business establishments. Just as in the last century, when the French desired to colonize Cayenne; what beautiful descriptions did they give of the fertile country, with its luxuriant flora, its wonderful forests, and its ravishing prairies! When the thousands and thousands of colonists who were sent there had perished to the last man, the French settled down to admire the photographs of those wonderful forests and stay quietly at home, leaving to those whose ethnological province is in Cayenne the task of propagating themselves and attending to their affairs. I have no doubt that we shall soon be forced to follow this example, and I hope that the frankness with which I declare this conviction will prompt us all to fulfill the duty which this great popular movement imposes upon naturalists and physicians. It is our duty to take hold of the question and organize the study of it, and to arm ourselves with scientific methods for the exploration of these distant countries, and for ascertaining to what point a permanent colonization in them is possible.

We need more than isolated examples to satisfy ourselves of the adaptability of the white race to fix itself in this or that place. A peculiar population exists in the mountainous region of the Island of Réunion, called "*petits blancs*," or little whites, who have been ascertained to be the last remains of the French colonists who established themselves in that part of the island a great many years ago. Recently a French traveler discovered in the Vindhya Mountains, in India, some survivors of a French colony which was founded there three centuries ago. There is nothing impossible in these facts; but they singularly remind us of the exotic conifers which are planted in our experimental forests. Now and then a forester has a success with one of them, and the little plant becomes an object of curiosity to travelers and the people of the neighborhood. But the number of these plants is insignificant. They are isolated examples or rarities, and no particular importance can be attached to them.

All these facts, I repeat, only make us feel more keenly how desirable it would be to determine scientifically the conditions which make the existence of our vulnerable race on a foreign land possible. We might then direct our emigrants with the same certainty as that with which a modern captain, who knows their wants, provides for his troops. As I look at it, I can not regard the mission of naturalists and physicians toward their nation as conscientiously performed till a satisfactory solution is given to this problem.

INSTINCT AS A GUIDE TO HEALTH.

By FELIX L. OSWALD, M.D.

SINCE the beginning of the sixteenth century, when the clouds of the middle ages were broken by the first sun-glimpse of reawakening reason, the average longevity of the North Caucasian nations has increased nearly seven years. In Northern Europe and North America the progress in the practice, if not the science, of healthy living has, indeed, kept fairly step with the general advance of civilization; the worst heresies against the health-laws of Nature have become errors of the past. Unventilated dwellings have become unpopular. Phlebotomy has gone out of fashion. We have ceased to fuddle our children with beer-soup. Hygienic reform has everywhere modified our habits of life.

Yet the principle of that reform has strangely failed to be recognized. For one invalid who can steer a straight course to the harbor of health, a thousand weather the breakers in a random, empiric way, like untrained sailors, failing to comprehend the purpose of the beacon, though using its light to avoid the nearest cliffs. Nay, if the source of that light were indiscreetly revealed, it would frighten hundreds back into utter darkness, to scan the firmament for a glimpse of its vanished loadstars, rather than trust their safety to an earthly guide. For, with the progress of a practical regeneration, a theoretical adherence to the traditions of the past still goes hand in hand. Not all civilized Buddhists have renounced the Dalai Lama; and many of our progress-loving contemporaries would be rather alarmed at the discovery that the principle of our social, medical, and educational reforms during the last two hundred years has been a *restored trust in the competence of our natural instincts.* So foreign was that rule of conduct to the moral standards of the middle ages that its importance was recognized only in its apparent exceptions, the supposed "evil propensities of our unregenerate nature," such as poison-habits, sloth, and sexual excesses. The real significance of such aberrations would reveal the difference between natural appetites and abnormal (artificially acquired) appetencies, and teach us the necessity of applying the tests of that distinction to all persuasive instincts, and occasionally to otherwise unexplained aversions.

But even within those limits a critical study of our protective intuitions would surprisingly show in how many respects the hygienic reforms of the last two hundred years could have been anticipated by the simple teachings of our senses. For the wards of instinct a temperance sermon would be as superfluous as a lecture on the folly of drinking boiling petroleum, for to the palate of a normal living being—human or animal—alcohol is not only unattractive, but violently repulsive, and the baneful passion to which that repugnance can be forced to yield is so clearly abnormal that only the infatuation of the natural depravity dogma could ever mistake it for an innate appetite. In defense of the respiratory organs, Nature fights almost to the last. The blinded dupe of the night-air superstition would hardly assert that he finds the hot miasma of his unventilated bedroom more *pleasant* than fresh air. He thinks it safer, in spite—or perhaps because—of its repulsiveness. "Mistrust all pleasant things" was the watchword of the mediæval cosmogony. Long before Jahn and Pestalozzi demonstrated the hygienic importance of gymnastics, children embraced every opportunity for outdoor exercise with a zeal which only persistent restraint could abate. Sexual aberrations are a consequence, oftener than a cause, of disordered health. Instinct has always opposed the abuse of drugs, the delusions of asceticism, the suicidal follies of fashion. Instinct has never ceased to urge the reforms which our times have at last reached by such circuitous roads, and the study of its pleadings and protests might shorten those roads for the leaders of future generations.

On the other hand, it must be admitted that perverted appetites can become as irresistible as the most urgent natural instincts. Nor can it be denied that in some exceptional cases Nature fails to advise us of perils which her warning could easily avert, though we should remember that her standards of expediency are not always our own, and that, as a rule, instinct asserts itself at the fittest times, and with an urgency proportionate to the importance of its mission.

The exceptions, thus far only partly explained, may be summed up under the three following heads: 1. Perverted Instincts.—The physiology of certain abnormal propensities is as obscure as the origin of sin. There is no doubt that the innate aversion to any poison known to modern chemistry can, by persistent disregard, be turned into a morbid appetency, *vehement and persistent in proportion to the virulence of the poison.* The most plausible hypothesis suggested in explanation of that fact seems to be the conjecture that, in adapting itself to the exigencies of abnormal circumstances, the constitution of the organism has to undergo certain modifications, considerable in extreme cases, and correspondingly less easy to undo. For every "second nature" is, probably, a compromise with the persistency of untoward conditions. Iron-workers become less sensitive, and at last rather partial, to the fervid temperature of their workshops. Butchers, like the North American Indians, and other *carnivora*, are apt to contract a disposition which enables them to pursue their sanguinary vocation with callousness, or something akin to satisfaction. Slaves become sneaks, i. e., amateur flunkeys. The love of light, too often punished with *autos-da-fé*, becomes a love of dusk, if not of darkness; the Arian skeptic subsides into a resigned Capuchin—Nature forbears to maintain a hopeless struggle. For similar reasons, perhaps, she yields to the persistent infatuation of the self-poisoners, called topers and opium-eaters. Further resistance would imply chronic sea-sickness, and, under the circumstances, an abnormal fondness for strong drink may appear a lesser evil. Yet the characteristics of such propensities distinguish them clearly from a natural instinct; they have to be artificially acquired, their importunity knows no limits, and their free indulgence is always followed by a depressing reaction. Thus, even in yielding, Nature remains true to her preordained laws. No one can hope to evade their self-avenging rigor, though the mode of retribution may take the unexpected form of chaining the miscreant to his idol.

2. Abnormal Perils.—The dangers incident to our artificial modes of life seem now and then to deceive the foresight of instinct in a way typified in the non-repulsiveness of certain mineral poisons. Nature has taken ample precautions to secure her creatures against the poison-perils of the upper world—hemlock, foxglove, and belladonna—but failed to provide safeguards against such subterranean evils as arsenic, or the social dangers yet slumbering in the womb of Time. Providence, however, may have foreseen that perils evoked by the potent hand of Science could be avoided in the same way; though the struggle for existence may, in the course of time, evolve supplementary instincts. Those fittest to survive, methinks, already begin to evince an intuitive aversion to the sugar-coated poisons that have reduced our average longevity to less than forty years. The world is getting prudent by natural selection. The children of the twentieth century will not be apt to overrate the nutritive value of fusel-oil.

3. Parasitic Disorders.—The healing instincts of Nature, which teach the surfeited brute to abstain from food, somehow fail to take cognizance of the disorders caused by the agency of microscopic parasites, entozoa, etc. It has been suggested that the development of such organisms is as foreign to the *autonomy* of the human system as the growth of the mistletoe is to that of the oak, and thus escapes the jurisdiction of its self-regulating laws. But a still more suggestive circumstance is the fact that disorders of the class named reveal their origin plainly enough to permit a direct removal of the cause, which,

in other ("symptomatic") diseases, is often aggravated by the suppression of its external manifestations. In other words, Art is here competent to deal with the hostile "power behind phenomena," and Instinct resigns its mission to Reason.

It is still a mooted question if tuberculosis can be included among the "germ-diseases" of this class; but attention has been called to the circumstance that a certain stage of pulmonary consumption stimulates the sexual instinct to a degree which can hardly be supposed to benefit the exhausted state of the organism. The study of that indubitable fact offers a curious problem, but also a solution which considerably modifies the apparent paradox. The truth seems to be, that the tendency alluded to manifests itself only in a far advanced and practically hopeless stage of the disease, when Nature sacrifices the interests of the individual to those of the species. Moths, impaled in the collector's show-case, often pay an interest on the debt of Nature by a deposit of numerous eggs. Many plants ripen their fruit just before the end of the season. At the brink of Styx doomed men are apt to renounce individual cares and become eloquent for the benefit of posterity. It is Nature's law of reversion. It is also true that far-gone consumptives are very apt to indulge in exuberant hopes, belied by an event which they can hardly have helped to postpone.

But it is equally certain that, in a far larger number of diseases, instinct is the safest guide to recovery. The overloaded stomach rejects food; the exhausted system at last accepts no compensation but sleep. Wounded animals crouch motionless in their hiding-places; instinct informs them that rest increases the chances of recovery. The unrest of asthma-patients intimates the surest remedy—change of air and outdoor exercise. Fever-patients pant for refrigeration. Dyspepsia can be avoided by heeding the premonitory symptoms—the want of appetite that accompanies the first stage of chronic indigestion. In the incipient stages of scurvy, and many enteric disorders, the organism demands a change of diet as urgently as the perspiring skin clamors for a change of temperature. But when has that instinct ever clamored for drugs? If suppuration fails to dislodge a thorn, the skin of the inflamed parts becomes tenuous, and at last prurient, and not only tolerates but invites excision. We see, then, that instinct can adapt itself to abnormal circumstances, and the question recurs: In what state of distress does our stomach cease to protest against the compounds of the drug-monger? Or, shall we believe that our protective instincts, at the most critical moments, become false to their mission, and urgently warn us against the means of salvation? Yet, against ninety-nine of a hundred remedial drugs they protest with a persistence which can be overcome only by such juggles as lozenges and sugar-coated pills. That protest is a cliff which will ultimately wreck all the arguments of the castor-oil school. Home-sickness, if curable only by a counter-poison, inspires its victims to seek relief in friendship (attachment transferred to less inaccessible objects), and sometimes in religious fervor—yearning for a home which even an impecunious traveler may hope to reach. Pliny marvels "how greatly disappointed love inspires to deeds heroic"; yet heroism, in the ancient active sense, self-devotion to hard work and rough-and-tumble campaigns, is, in truth, the best cure for the ailments of sentimental sorrow. The mountain-mania of worn-out brain-workers, their passionate longing for the occupations of their nature-abiding ancestors—hunting, camping, and horticulture—are inspired by the instinctive desire to re-establish the structure of their organism on the basis of its original foundations, and recover, as an uprooted tree might revive in the mold of its native soil.

The purpose of such intuitions has rarely been fully recognized, and there is no doubt that the most useful contribution to the medical literature of this century would be a popular treatise on the Revelations of Instinct. The didactic significance of those revelations may even be destined to become the basis of a special science. That science would help the votaries of reform to atone for the grievous heresies of the past. It would make the healing art an ally of Nature: it would preserve us from manifold social and educational errors, by guiding progress along the lines of natural ordination. A science of instinct would be the commentary of a gospel which, in the language of man, has almost ceased to be its own interpreter.

THE INCREASING CURSE OF EUROPEAN MILITANCY.*

By A. R. WALLACE.

SINCE the year 1870, but more especially since 1874, the general war expenditure of Europe has increased enormously. This is partly a consequence of the Franco-German War which so greatly enhanced the military power of united Germany and led other nations to aim at a corresponding increase in their forces, and in part to the enormously increased cost of iron-clad ships, monster guns, torpedoes, and all the scientific appliances of modern warfare.

Up to the year 1875 our own army and navy had increased but little for many years, the total expenditure in 1874 being £24,664,000, which was somewhat less than that of 1864. But since the former date our outlay on the two services has risen greatly, and now amounts to £28,964,000, an increase of more than four millions. The number of men has increased from 189,000 in 1874 to 197,000 in 1884, exclusive of the Indian army.

* Chapter V of "Bad Times," by Alfred Russel Wallace, LL. D. Macmillan & Co., 1885.

In most of the great states of Europe the increase both of men and of war expenditure has been far greater than ours. Austria up to 1874 spent less than seven millions on her army; she now spends £13,433,000, with an increase of about fifteen thousand men. France has increased her forces by fifty thousand men in the last ten years; while her military and naval expenditure has nearly doubled since the war, and now reaches the enormous sum of £35,500,000. Germany during the same period has raised her war expenditure by more than three millions, the present amount being £20,050,000. Italy has doubled her war expenses since 1873. In that year they were a little over nine millions, now they are £18,900,000. Russia has followed the same course, having increased her war expenditure from less than twenty millions in 1870 to £33,000,000 in 1884.

The loss involved in these huge armaments is of three distinct kinds: 1, by the number of men, mostly in the prime of life and of the very best physique, who are kept idle or unproductively employed; 2, by the burden of increased taxation which the rest of the community have to bear; and, 3, by the actual destruction of life and property in war, which, wherever it occurs, inevitably diminishes for a time the productive and purchasing powers of that country. Let us endeavor to form some conception of the amount of loss due to each of these causes.

From information given in successive issues of the "Statesman's Year-Book," it appears that, since 1870, the armies and navies of Europe have been increased by about 630,000 men on the peace establishments. This number of men, therefore, has been wholly withdrawn from productive labor; but during periods of war a much larger number is thus withdrawn, and the country is, to that extent, still further impoverished. But the total number thus withdrawn, though very large—the standing armies and navies of Europe being estimated at 3,683,706 men—represents only a portion, and perhaps even a small portion, of the mischief done, since the numbers employed in the equipment of this force and in the production of the vast and complex war-material now used are, not improbably, very much greater, and these are all equally lost for productive purposes. If we think of the hundreds of huge iron-clad ships which have recently been built, and try to form a conception of the number of men employed upon them directly and indirectly—from those who dug out the iron-ore, and the coal used to smelt the ore, to those who construct the huge and beautifully finished marine engines—from the men who felled the trees in Canadian and Indian forests to the skilled workmen who design and frame and finish with elaborate care the whole of the internal fittings—we shall be convinced that to build one of these monster vessels requires from first to last a small army of men, all of whose labor, so far as any benefit to mankind is concerned, might as well have been employed in pumping water out of the sea and allowing it to flow back again. Then consider the equipment, clothes, arms, and ammunition of all these great European armies; the manufactories of powder and explosives, the monster guns and projectiles, the rockets and torpedoes, the horses and horse accoutrements, and all the innumerable variety of stores that are required to supply a modern army in the field—and then follow back every one of these things to the raw material brought from various parts of the world, and to the numerous processes of manufacture through which it has to pass—and further consider the amount of purely intellectual power required, the origination and improvement and detailed designs for the rifles and cannons, the projectiles and explosives, the pontoons, the fortifications, the torpedo-boats, and the iron-clads—and we shall probably think it not an extravagant estimate that for every ten thousand men in a modern army and navy at least another ten thousand are wholly employed in making the necessary equipment and war-material, the labor of the whole twenty thousand being utterly wasted, inasmuch as all that they produce is consumed, not merely unproductively and uselessly, but destructively. We may fairly estimate, then, that the military preparedness of modern Europe involves a total loss to the community of the labor of about SEVEN MILLION men, and a corresponding amount of animal and mechanical power and of labor-saving machinery. If, now, we consider that the weight of guns, the thickness of armor-plating, the size and engine-power of ships, and the complex requirements of an army in the field, have all been rapidly increasing during the last ten or fifteen years, we may fairly estimate that one fourth or one fifth of this number of men have been abstracted from the productive workers of Europe during the last ten years, the period over which the commercial depression has extended.

Let us next consider the heavy burden of taxation upon all the chief European peoples, the increase of which during recent years has been almost wholly caused by increased military expenditure and the interest on debts incurred for wars or preparations for war, for fortifications, or for military railways. This increase may be best estimated by comparing the expenditure of 1870, the year before the Franco-German War, with that of 1884. During this period of fourteen years our own expenditure has increased from £75,000,000 to £87,000,000; that of Austria from £55,000,000 to £91,000,000; that of France from £85,000,000 to £142,500,000; that of Germany from £54,000,000 to £112,500,000; that of Italy from £40,000,000 to £61,500,000; and that of Russia from £66,000,000 to £114,500,000. Altogether the expenditure of the six great powers of Europe has increased from £345,000,000 to £612,000,000, an additional burden of £266,500,000 a year. The population of these six states is now a little over 269,000,000, so that they have to bear, on the average, an addition of taxation amounting to nearly a pound a head, or about five pounds for each family, a most oppressive amount when we consider the extreme poverty of the masses in all these states, and that even before this period of inflated war expenditure they had already to support a heavy and often an almost unbearable load of taxation. We must, therefore, admit that this great addition to their fiscal burdens in the last fourteen years must have seriously diminished the purchasing power of more than two hundred millions of people, and this alone is calculated to produce, and must actually produce, a depression of trade in all the countries which supply their wants, and therefore in none more seriously than in our own.

There remains yet to be considered the injury done by the actual destruction of life and property which occurs whenever this elaborate and costly war-machinery is put to its destined use. Owing to the wide extent and endless ramifications of modern commerce, wherever life and property are destroyed by war all nations with an extensive foreign trade must feel some of the consequences. When villages and towns are burned or bombarded, crops devastated, and domestic animals taken by invading armies, troops quartered on the inhabitants and forced contributions made, the result must be the impoverishment of the population for several years. For a long time they have a severe struggle even to exist. Their houses have to be rebuilt, their lands to be again cultivated, seed and domestic animals to be procured, fresh capital to be accumulated ; and till all this is done they have no means of purchasing foreign goods or of indulging in anything beyond the barest necessaries of life. And, when the war is long and destructive, there is, in addition, the loss of human life, not merely by slaughter in battle, but by the distress and exposure, the disease and famine which are the inevitable consequences of war, a loss often to be counted, not merely by thousands and tens of thousands, but even by millions. And all these lost lives are, from our present point of view, lost customers, and thus still further increase the sum total of injury to commerce which war produces.

Now, during the last twenty years there have been a continued series of wars which have all, more or less, tended to produce these injurious effects. Beginning with the New Zealand war in 1865, we have in succession the Abyssinian war of 1867, the great Franco-German war of 1871–'72, the Ashantee war in 1875, the terrible Russo-Turkish war of 1878, the Transvaal, Zooloo, and other South African wars of 1879–'80, the Afghan war of 1881, the Egyptian war of 1883, and the Soudan war perhaps not yet concluded. Who can calculate the amount of life and property destroyed, and the consequent misery and impoverishment of large populations during these twenty years? Traders have, unfortunately, often considered war to be advantageous to them, on account of the rapid and reckless expenditure of public money on war-materials and stores, and the opportunity of making large profits by war-contracts. But this is a very partial effect and limited to but few departments of trade, while the depressing effect of war, in the increased taxation it always involves and in the impoverishment of our customers which it always produces, is certain, widespread, and often enduring. The recent wars in Egypt and the Soudan, whatever other results they may have, will assuredly have the effect of tending still further to prolong and intensify our commercial depression.

If our manufacturers and merchants as a body would consider this question in all its bearings they would surely arrive at the conclusion that all war, wherever or by whomsoever waged, is bad for trade, since it impoverishes alike the winner and the loser, the invader and the invaded, while it inevitably destroys a number of actual or possible customers. The moral arguments against war would doubtless be more generally effective if it were clearly seen that, always and everywhere, its direct and necessary effect is to produce more or less of depression of trade.

But if war injures the capitalist, the manufacturer, and the trader, still more does it injure the worker, and on this point I can not do better than quote the forcible words of Mr. Mongredien.* After describing the various destructive agencies and methods of war, he says: "As wealth dwindles somebody must suffer, and the suffering mainly falls on the poor and weak. The capitalist is mulcted of part of his wealth, but he can wait. The labor-seller is mulcted of the necessaries of life, and he and his dear ones can not wait. The less there is to produce the less there is to distribute. Need we say which class it is that will run short? It is on you, labor-sellers of the world, that the burden chiefly falls. It is you who are the slayers and the slain. You form the rank and file who deal the blows and on whom the blows are dealt. To your chiefs belong the honor and the rewards. As for you, you are under contract to suffer and to cause suffering; to inflict and to endure death; to destroy instead of creating wealth; and to use every effort to suppress the fund out of which labor is paid. The war-system, pernicious to every class, is a special curse to yours. Are you content to view it as a necessity? In this our protest against it, we look for your special assistance by thought, word, and pen. Public opinion is made up of assenting units." Since these words were written the working-men of England have obtained the means not only of verbally protesting, but of actually deciding against war, if it so pleases them. If they will vote for no representatives but such as will pledge themselves to oppose all but strictly defensive wars, and never to begin a war until we are actually attacked, then war will rarely occur, war expenditure will be reduced, and, so soon as other nations follow our example and that of the United States, one of the chief causes of depression of trade will cease to exist.

* "Wealth Creation," by Augustus Mongrieden, p. 115.

MEDICAL PRACTICE IN DAMARALAND.

By C. G. BÜTTNER.

THE missionary in Damaraland has also to be a physician. The stations in that country being cut off from regular intercourse with European civilization, the missionary societies have been obliged to give their agents a medical education, in order, if for no other purpose, that they may be able to doctor themselves and their families. From my own station of Otimbingue, which is well situated as compared with some of the others, I would have had to go at least a month's journey to find a regularly graduated physician. Of course, the natives are glad to avail themselves of the benefit of what medical skill we may have, the more especially as they have learned that we will never intentionally do them any harm, while they are always suspicious of their own doctors and sorcerers. Hardly a day passed during my residence in the country that I was not called upon by some sick person; so that I am able to speak from the results of a seven years' busy practice. As I could converse with the natives with perfect freedom in their own language, I had frequent opportunities to consult with their professionals, and was able to learn more of their notions than usually falls to the lot of the ordinary explorer; so that, though not a physician by profession, I believe I can make some interesting contributions to medical lore.

One of the most curious results of my observations is that the climate of Damaraland possesses what we might call an antiseptic character for several months of every year. The quality is an attendant of the long annual drought. Every living thing suffers during that period from the excessive heat, and much comfort is impossible, even in the shade, while, in places exposed to the warm winds, the thermometer has risen to 129°; and the sand, unmoistened for six months, becomes so hot that I have seen eggs hardened in it. This arid heat is opposed to the propagation of ferment, for it dries up everything that is exposed to the wind before it has time to sour. No manifestations of tuberculosis are known. Wounds of every kind heal remarkably quickly and well, without enough suppuration taking place to make the bandages stick. The manner in which large, neglected wounds heal of themselves would form an interesting study for a professional surgeon. I observed a case of a Herero whose right lower arm had been shattered in battle by a musket-ball. The healing process had worked itself out in such a way that the whole lower arm with all its muscles had become withered and useless, while the upper-arm bone was whole and covered at its lower end only with the brown skin. All the muscles and ligaments of the elbow-joint had vanished, while the shoulder-muscles remained, so that the unpleasant spectacle was presented of the man appearing to gesticulate with his bones. A woman lived at our station whose feet had been barbarously cut off in some war several years before, so that her captors might more easily get off the iron ornament which the Herero women wear on their ankles. Athough the woman had to lie helpless for a long time, her wounds eventually healed up, and now she has been hopping around on her knees for thirty years.

We soon remarked, however, when the rains fell, a *genius epidemicus* coming over the country and demanding offerings. We could also see how those of the natives who lived on the ridges were much less troubled by illness than those whose houses were situated on the moister alluvial ground and in the river-bottoms. Those who have once had fever are more readily exposed to attack than those who have never been ill. My wife, who appeared to have wholly recovered from a recent illness, only required a stay of ten minutes in a river-bottom, where I and several other persons received no injury, to be put in bed for months. The influence of malaria is manifested in many persons in other ways than by fever-and-ague. Thus, I never had that disease; but, when others of the family had fever, I had rheumatic pains in my joints, and I knew of other persons who were similarly affected. Occasionally a severe and almost universal influenza would prevail instead of the fever; and, while few died from it, it was very painful, and sometimes laid entire households low, so that no one was left to attend to the daily duties.

One of the most prevalent diseases is a running inflammation of the eyes, which few natives escape suffering from one or more times during their lives. Europeans also are usually attacked by it, and it was a great wonder to the natives that I and my family escaped it. We avoided it by the observance of the most scrupulous cleanliness and the use of prophylactics.

Venereal disorders are quite widely spread, but the Hereros have no name of their own for them, and call them the "Hottentot disease."

A peculiar skin-disease, called *otiyndimba*, causes much inconvenience. It is connected with the hot weather, and is characterized by little sores that appear upon different parts of the body, lasting for two or three weeks, to be succeeded by others till the cold weather. They develop pus, in quantity which appears to be very scanty in proportion to the pain they cause, and leave no scar. The only disturbance they produce in the general system appears to be to make the sufferer very uncomfortable.

Two cases of snake-bites were brought to me, one of which was without consequences, while the other only resulted in a trifling sore. Yet cattle are frequently killed by snakes. I had several cases of men who had been spit in the eyes by the spitting-snake, or *ongoroka*. Some persons regard this serpent as a myth; but I have conversed, not only with natives, but also with trustworthy Europeans, who have seen it spit. The attack produces a running inflammation in the eyes, which lasts for about a fortnight.

The various behavior of the natives toward surgical and internal disorders is curious to the European. No one can be more indifferent than they are to external injuries and the pains they occasion. Except in the rarest cases, they never utter a sound or move a limb, whatever may be done to them. A thoroughgoing surgeon could not want better subjects; and only when the question is directly asked them will they admit that they suffer any pain. An illustration of this power of endurance is given by the poorer mountain Damaras, whose clothing, for summer and winter, is reduced to a mere loin-cloth. Their only way of warming themselves in cold weather is to hover over the fire as closely as possible. They thereby become blistered nearly from head to foot, and acquire a rather mottled appearance; yet they never seem to mind the smart of the burns. But let them suffer from any slight internal disorder, if it be no more than a common cold, no one can touch them, and it is very hard to make them submit to a medical examination. It was common in our school when one asked a person suffering from such a disorder, "Where do you suffer the most pain?" for him to return the answer, "In my arms, neck, head, back, stomach, all over my body." These imaginary sick gave us a great deal of trouble, and it became necessary to keep them as much out of the way as possible. I found an effectual means to accomplish this, and one that was characteristic of the people. I ordered calf-soup for the sick man. To kill one of their calves was more than the Hereros were willing to do just to make a sick man well; and no one to whom I made this prescription ever came to me a second time.

Massage plays an important part in native therapeutics, and is applied upon the whole of the lower part of the body and the bowels. I can not deny that this operation is quite thoroughly and in a manner scientifically performed. It is a circumstance favorable to this process that the skin over the abdomens of the natives is stretched and flabby on account of their custom—which arises from their necessities—of overeating at times, and at other times having to endure long hunger. The operator, first with a slow, light, but continuous movement of his oiled finger-tip draws the bowels clear over to one side till he can plainly feel the inner part of the hip-bone with its muscles and vessels on the other side; then the bowels are slowly pushed back, with a movement so executed that every knot and every induration is rubbed as thoroughly as possible between the fingers. A number of the unpleasant symptoms that may arise from costiveness, uterine disorders, or the troubles of pregnancy, are removed by this operation, and it can not be denied that the effect of the kneading on the circulation is beneficial. The whole process lasts from an hour to an hour and a half, and in serious cases is repeated every two or three days.

The men who perform massage have by repeated practice acquired a fair knowledge of the normal condition of the abdomen, and of the more usual irregularities that take place there; and they have also, by practice in cutting up slaughtered animals, gained some knowledge of the anatomical relations of the parts. I have satisfied myself, by close observation of the procedure, that every part can be so fully separated from the others as to permit the whole to be plainly felt by the finger.

The skill attained in this art is particularly serviceable in midwifery cases, and makes up in a great measure for the lack of instruments. By it faults in the position of the fœtus are soon discovered, and much skill is displayed in remedying them. Even the white women are not afraid to call in the native midwives; and they can really be recommended without peril. As a rule they are women of the higher social ranks. The art of massage is handed down from mother to daughter, or to other relatives of the younger generation. Occasionally men practice at it.

Chest-diseases and pains in the extremities are treated by cupping and the moxa. Cupping is done with a horn. The skin having been scratched with a knife, the larger end of the horn, which has an opening at the point, is placed over the wound, and the operator sucks out the air and as much blood as he can, making of himself a kind of an artificial leech.

Moxas are preferred for diseases of the lungs and liver, and are applied in the simplest imaginable manner, by burning the end of a stick and putting the glowing coal upon the skin. Some ten or fifteen points are thus burned in succession, the scars of which afterward look like a kind of tattooing. When I first saw these scars on the breasts and backs of the Hereros, I thought they had been made for decoration, but was soon set right in the matter.

For internal remedies the people have a considerable number of simples. Every one knows of a few plants that are good as laxatives, emetics, sudorifics, or quietives. Among the heathen natives, supernatural help appears to be regarded as more important, and to be more approved. It is invoked, I observed, in two forms: One kind seems to be a traditional survival of the old patriarchal sacrifice; and the other embraces a kind of combination of secret knowledge with jugglery. A very obvious distinction is made between the two kinds of invocation, in the fact that some honorable member of the family is chosen to officiate in the former, while the latter is left to some wretched charlatan, or juggler, who sometimes has to suffer death as a penalty for his practice. In the former kind of invocation a beast is always slain, with whose meat and fat certain ceremonies are performed and formulas uttered over the patient, in a way that has been handed down by tradition.

One of the simpler features in the practice of the juggler-doctors consists in the practitioner sucking at the afflicted part of the patient till he brings out the thing that has produced the sickness. So long as these things are beans, pumpkin-seeds, and the like—and these are what the doctor generally finds—there is nothing about the matter that passes our comprehension. But when I saw one of these performers, entirely naked except for a little skin-apron, who was closely watched by many curious persons, at last draw out a living snake, a foot and a half long, I was somewhat astonished. It was a real snake, for the by-standers hastened to kill it. If the sick man failed to get well after this kind of procedure, the burning coal was applied to him. Hottentot quacks generally give the patient to drink of a kind of tea which they compound from plants known to them, and which should cause him to vomit. For the cure to succeed they must find the object by which the man was bewitched and made sick, in the vomited matter. These objects are things which can not usually be found in the stomach nor come out of it. Thus my friends were shown, among the things that had been in this way taken from patients, large pins with glass heads, neatly tied together, crosswise, with a red thread, a piece of wood with several twigs forking from it, and almost as large as the hand, and other things equally curious. So far as I could learn, this process is usually applied to a St. Vitus's dance, which is supposed to be caused by enchantment.

I close with the relation of an incident in which I was made to play the part of the magic doctor, because it exhibits one of the characteristics of the people. A Hottentot came to me with a story of his nephew being bewitched, and said that he had sought me out after several other white men had declined to help him, because they knew nothing about witchcraft. His nephew, he told me, had been quite well till he had been bewitched by a rival in a love-affair, and nothing could now be done with him, for his convulsions and running around. As this condition had come about all of a sudden, the suggestion of some external cause for it was obvious, and I was satisfied that it was a case of poisoning. For the quacks are adepts in the management of snake and plant-poisons, and produce all their enchantments, when they amount to anything, by some means of the kind. I was glad to have the opportunity of dealing with one of these cases by a remedy of my own. I gave the man a bottle of camphor, with directions for using it, and told him to come back and report the result in a fortnight. He came three weeks afterward, with the empty bottle, and told me joyfully that the sick man was well; he had vomited up the lion's hairs in which the enchantment was lodged!—*Translated for the Popular Science Monthly from Das Ausland.*

THE PROBLEM OF PHOTOGRAPHY IN COLOR.

By OGDEN N. ROOD,
PROFESSOR OF PHYSICS IN COLUMBIA COLLEGE.

MY attention was first called to this subject in 1853. At that time I was an assistant in the "Yale Analytical Laboratory," which afterward developed into the present Sheffield School. The interest of the Professor of Chemistry, John Porter, was excited by some articles on this subject which had recently appeared in France, and he was desirous of making experiments to test an idea that had occurred to himself. The sensitive surface was to be prepared while actually under the influence of colored light, so that from the start the colored rays should be able to act on it and influence the molecular condition of the newly formed combinations. A prismatic spectrum was to be employed, and it was hoped that the red rays would persuade the newly born silver salts to reflect red light and only red light, while the same salt, when generated under the influence of the green rays, by the aid of this early education was to be made capable hereafter of reflecting green light, but incapable of reflecting red, yellow, or blue light. Expressed in the language of the undulatory theory of light, the idea would be about as follows: expose molecules in act of formation to the long waves of red light, and ever after they will be capable of reflecting mainly the long waves of red light; all other kinds they will absorb and convert into heat.

This task having been assigned to me, I entered on it with zeal, and arranged a dark room; the solar spectrum was made to fall nicely on the table, and many of the processes known at that time were in succession tested. The photographs of the spectrum thus obtained were not at all uniform in color; sometimes they would be delicately shaded from a dull-red gray to a blue or violet-gray and often they presented minor changes of color variously disposed. Favorable indications were followed up as they presented themselves; but after a time I became convinced that the play of color in the photographs was solely due to the greater or less energetic action of the light upon the sensitive substance, and that exactly the same results could be obtained by using white light, more or less intense. When the work was finished, I presented my written report with the photographs, and the professor, after studying it, came to the same conclusion. The "nascent" idea was not feasible.

And yet photographs in color of colored objects have been obtained. Upon one occasion, about twenty-five years ago, I obtained a very fine one. The subject was a large elm-tree and a red farmhouse, these two objects filling up almost the whole plate. The ordinary wet-collodion process was employed; the negative, after being removed from the hypo, was washed and dried as usual; but, when I examined it by reflected light, it turned out that the green tree was colored dark green just as nicely as if it had been a camera image, and the red house was not a bit behindhand in truth and delicacy of hue. A photograph in colors, sure enough! But an examination with a lens, and a little turning and twisting of the plate, caused the illusion to vanish: the colors were those of "thin plates," soap-bubble colors, caused by the interference of light. Wet collodion often shows them in patches when it is somewhat rotten, and this sample was very rotten. The interference effect had nothing to do with the *color* of the light, but was controlled by its intensity. Once I had a chance to examine some photographs in color of gayly dressed dolls made by Niepce de Saint-Victor, and it seemed to me that the pale colors they presented were produced by a species of interference, acting by means of the presence of *more* or *less* finely divided particles. The details of my examination I do not recollect, but merely the conclusion that the appearances presented were due to causes analogous to those that were effective in the case of my glass negative. Photographs in color, such as they are, can be obtained with sufficient patience; but, in order to give this fact the slightest value, it is necessary to prove that a corresponding amount of patience would not be rewarded by the production of colored photographs of objects which were gray, light gray, dark gray, etc. When we think we have made a discovery, our first duty is to destroy it mercilessly if possible, and the reproduction of the same effects with white or gray objects is the proper mode of administering justice in this case. It is barely possible that some one may ask why a process that renders the colors correctly is a failure merely because corresponding colors can be obtained when the natural objects are tinted gray. The question answers itself; white and gray objects will be colored in the photograph, and, worse than that, the same color in the natural object will vary in the photograph with its brightness or luminosity.

Let us now examine this subject from a theoretical point of view, and ask ourselves why we should hope that photographs in color could ever be produced. We see the rich red rays of the spectrum falling on the plate, and we imagine that a substance which is sensitive to light will somehow be acted on by them, and arrange itself so that ever afterward it will better be able to reflect red light than any other kind of light. Why? Why should a substance that has been acted on by long waves be better able to reflect long waves than those that are shorter? Why should a sea-beach that has been acted on by long waves be on that account better able to reflect and redirect to the ocean long waves rather than mere ripples? The waves of light produce in sensitive substances chemical changes; new compounds are formed; why should the long waves of red light produce compounds that are especially capable of reflecting long waves, or red light?

When we undertake to make a photograph in color, in effect we ask one and the same chemical substance to reflect for us long, medium, or short waves, red, green, or blue light, according as it has been acted on by waves of greater or lesser length. The demand seems to me preposterous.

The hope for photography in color lies in a different and less independent direction. By the use of suitably colored plates of glass placed before the lens of the photographic camera, it is possible to obtain ordinary negatives of the red, yellow, and blue constituents of a brightly colored surface—a carpet, for example. These can be made to yield red, yellow, and blue positives by the aid of the photo-lithographic process; and when these three positive impressions are superimposed on the same sheet of paper, a more or less successful reproduction of the colored object is obtained. The selection of the three transparent pigments used in printing is necessarily left to the taste and judgment of the operator, or I should say artist, as without considerable artistic knowledge the results are not likely to be valuable. It will be seen, then, that in this process photography is really made to act as an aid to chromo-lithography, and the results are really chromo-lithographs, the work being mainly performed by the camera and colored glasses. I do not see why it should not be possible in this way to reproduce more or less successful colored pictures of brightly tinted objects.

When we come to landscape the problem is more difficult, for a large part of its color consists of delicately tinted grays, the handling of which would be, to say the least, very troublesome, and would require far more than the superposition of the three layers of pigment just mentioned. For progress in this direction it would be necessary that the experimenter should, at the same time, be a skillful photographer, a good chromo-lithographer, and a landscape-painter. The results obtained would not be exact representations of natural scenery, but rather sketches in which the artistic taste presided over, modified, and massed together natural tints. They would be none the worse for that. Of course, there would still remain the difficulties connected with an artistic disposition of light and shade, and the still more insuperable ones of composition; for the disposition of objects in a landscape is rarely just what we want, or even what we are willing to tolerate. On the other hand, there are many simpler objects where this process* would probably succeed very well, such as colored designs of all kinds of decorated objects, and all those cases where the coloring is simple and not too evanescent.—*Photographic Bulletin.*

* Due originally to C. Cross and Ducos du Hauron, and improved by Albert, of Munich, and Bierstadt, of New York.

WOMEN IN ASTRONOMY.

By E. LAGRANGE.

THERE have been women famous in all the departments of science and art, and many have shown in astronomical studies talents not usually made manifest in their sex. To begin with ancient times, several women whose names have come down to posterity made themselves famous in the centuries before the fall of the Western Roman Empire. Among them, the principal one who derived her title to glory from the study of the sciences was Hypatia, daughter of Theon, of the school of Alexandria, who is nevertheless better known by her philosophical opinions than by her scientific labors. She lectured for many years at Alexandria, before numerous and intelligent audiences, on the Neoplatonic doctrines; but she is also known as the author of an astronomical table which has not come down to us. Wolf relates, in his "History of Astronomy," that she studied mathematics and astronomy with such success that she was given a professorial chair, whence she explained the works of Apollonius and Diophantus.

Skipping the ages of darkness and the beginning of the modern epoch, we find our attention fixed in the latter part of the seventeenth century upon the name of the family of Kirch—a name important in many respects. Marie Marguerite Kirch was born at Panitzch, near Leipsic, on the 25th of February, 1670. Her maiden name was Winckelmann, but she married the Berlin astronomer Godefroid Kirch, and became also his scientific companion. She assisted him in his calculations and observations, and in 1702 discovered a comet. Even after the death of her husband in 1710 she did not cease to devote herself entirely to astronomical science; and we have a considerable book which she wrote in 1712, in anticipation of the conjunction of Jupiter and Saturn that was to take place in 1713. The conjunctions of the planets now only excite curiosity, and are of no particular interest to astronomers. But the case was different in the times when astronomy was mixed up with astrology, and a very capricious, occult influence over earthly fates was attributed to such especial positions of the stars. With the progress of theoretical astronomy, which showed that these conjunctions were regular events, subject to periodic laws, the ideas on this subject were modified, and the writers upon the phenomena took the pains to notify the public, by the titles of their works, that they had nothing in common with the astrologers. Marguerite Kirch's book consisted wholly of astronomical calculations—to the honor, says Bach, of the woman and her age.

The daughters of Madame Kirch continued to occupy themselves with astronomy after the death of their mother, and made the calculations, for the Academy of Sciences of Berlin, of the "Ephemeris" and the "Almanac" which were sources of revenue to that learned body. In the same period a number of French and Italian astronomers had female collaborators in their own families. Celsius, the celebrated professor at Upsala, and a pupil of Kirch the son, was entertained, while passing through Paris to Bologna, by De l'Isle, whose sister was devoting herself to astronomy. Reaching Italy, he found likewise that his new master, Manfredi, had two learned sisters, engaged, like their brother, in the study of the stars. This caused Celsius to say, in a letter to Kirch: "I begin to believe that it is fated for all the astronomers whom I have had the honor of becoming acquainted with during my journey to have learned sisters; I have a sister, too, but not a very learned lady. To keep up the coincidence, we must make an astronomer of her."

Other women, whose names are less well known, wrote on astronomy during the seventeenth century. We may cite Maria Cunitz, daughter of a Silesian doctor, who published astronomical tables in 1650; Jeanne Dumé, who in 1650 wrote a book defending the Copernican system against "scientific" attacks upon it. Of more modern date was Madame Gabrielle Emilie de Breteuil, Marquise du Châtelet, who was for fifteen years the constant friend of Voltaire, and in her retreat at Cirey devoted her whole life to the sciences. She it was who first made known to France, then devoted to scientific Cartesianism and the doctrine of elementary vortices, the masterly work of Newton. This was a title to glory which might have made the fortune of more than one scientific man, and it fell upon a woman. Mademoiselle de Breteuil had received a very careful education, but her natural taste for study and serious occupations did not prevent her from shining brilliantly in the society of the courts of the Regency for some years after her marriage with M. du Châtelet. One of the best evidences of her genius that we have is in the bearing toward her of Voltaire, who had no respect for any but mental gifts. He had returned from Great Britain full of enthusiasm for English science and philosophy, and occupied with the dream of making Newton known to his countrymen and dethroning Descartes at the Academy. It may appear singular that he selected Madame du Châtelet for this work; but the choice was not extraordinary after all. She had already made some progress in mathematical studies under the direction of Maupertuis and Clairaut, and Voltaire was looking for the assistance he needed to some one outside of the official scientific circle. The translation of Newton's "Principia" would be the best means of making known in France the great English geometrician and the admirable simplicity which his theory of attraction lent to the study of the movements of the stars. This work Madame du Châtelet did well. But she did more than make a simple translation. The algebraic commentary which follows the translation is in large part the work of this lady, although it was composed under the direction of Clairaut and revised by him. "We have witnessed two prodigies," said Voltaire in his historical introduction to the "Principia"—"one that Newton should have composed this work, and the other that a woman should have translated and elucidated it." Leaving out the exaggeration natural in such a statement, there is still a great deal of truth in it. More than ordinary mathematical knowledge was necessary even to make known a work like Newton's immortal treatise, and still more to add explanatory comments to it. This, however, was not Madame du Châtelet's first scientific work, for she had previously written for her son "The Institutions of Physics," a book imbued with the Leibnitzian philosophy.

As may readily be imagined, Madame du Châtelet was likely to find more enemies than aids among the women of the light and frivolous society of her day. Fortunately, she was indifferent to criticism, else she would have suffered the pain of a hundred deaths.

The most distinguished of all woman-astronomers was Caroline Herschel, the story of whose life, already fully told in this journal (see "Popular Science Monthly," April and May, 1876), is familiar to our readers, and needs not to be repeated.

Madame Rümker, wife of the former director of the observatory of Hamburg, and his constant aid, discovered a comet on the 11th of October, 1847—the first comet discovered by a woman since Caroline Herschel had announced the last of her eight, fifty-two years before. [M. Lagrange has curiously omitted to mention the American woman-astronomer, Maria Mitchell, who is entitled to the place among discovers of comets which he here gives to Madame Rümker. She discovered a telescopic comet on the 1st day of October, 1847—ten days before Madame Rümker's discovery—in recognition of which she was given a gold medal by the King of Denmark. She has also devoted much attention to the examination of nebulæ, and has been employed in observations connected with the Coast Survey and in compiling the "Nautical Almanac." Her work has hardly been inferior to that of any of the women mentioned by M. Lagrange.—Ed. Popular Science Monthly.]

Another lady, who left very distinct traces of her work in astronomical science, was Madame Scarpellini, whom Italy claims as one of the children that have done her the most honor, and to whose memory a statue has recently been erected.

Catherine Scarpellini was born at Foligno on the 29th of October, 1808, and was a niece of the astronomer Feliciano Scarpellini, founder of the Capitoline Observatory, restorer of the Academia dei Lynceii, and professor in the two universities of Rome. Her attention was directed to scientific studies by her early training, with which her tastes fully agreed. Among her titles to fame we may recount that she organized the Meteorologico-ozonometric Station of the Capitol, and edited its monthly bulletin; she was one of the most active collaborators in the "Scientific Correspondence" of Rome; and, like Caroline Herschel, Madame Rümker, and Miss Mitchell, she discovered a comet on the night of the 1st of April, 1854. At a time when the subject of shooting-stars was under lively discussion she prepared the first catalogue of the meteors observed in Italy, and was the sole observer at Rome of the great shower of 1866. She also left valuable studies on the probable influence of the moon on earthquakes—a work which brought her distinctions from the Society of Naturalists of Moscow, the Geological Institute of Vienna, and other scientific bodies. Many learned societies made her an honorary member, and the Italian Government, in 1872, decreed to her a gold medal for her statistical labors. With all this she was a good mother and a true woman.

We mention a few more names: Madame Hortense Lepante, wife of the horologist of the same name, who calculated a comet with Lalande; Miss Ashley, of our own time, who has so intelligently studied the surface of the moon, and whose numerous labors are registered in the "Selenographical Journal"; and Miss Pogson, who is directing an observatory at Madras. Several young women are employed as calculators at the Observatory of Harvard College, in Cambridge, Massachusetts.

I can not close my article without giving grateful testimony to those women who, without having contributed directly to the advancement of astronomy, have sustained their husbands or brothers during their work with incessant devotion. This is a beautiful part reserved for the astronomer's wife or sister, and many women have known how to fulfill it with honor.

We recall with an emotion of gratitude the name of Mrs. Asaph Hall, whose persevering energy supported her husband when, despairing of success, he was on the point of abandoning the search for the satellites of Mars. With her encouragement, after long and painful watches, Mr. Hall returned once again to his investigations in a final effort, which was crowned with a most brilliant success. I must also, with all the friends of science, give a tribute of homage to Madame Janssen, who has exiled herself several times to the ends of the earth, and accepted the privations of the hardest kind of life, to follow her husband in his numerous astronomical voyages.

Honor, then, to all these ladies and fellow-workers, who are pleading or have pleaded more emphatically than the strongest speeches of philanthropists in favor of the claims of their sex. They have proved that when one will one can; and that proverb is perhaps the best conclusion that can be drawn from our story.—*Translated for the Popular Science Monthly from Ciel et Terre.*

SKETCH OF DR. W. B. CARPENTER.

THE long and busy scientific life of Dr. Carpenter, the wide extent and multifarious character of his researches, in which he was always a leader and always advanced knowledge, the catholicity of his views, the active interest he exhibited in every concern of life, his lovable personal qualities, and the painful circumstances of his death, have all contributed to invest the history of his career with an unusual degree of interest.

His life, as he observed to a friend less than a month before his death, was one of hard work. He was for years actively engaged in the drudgery of teaching; he was always preparing and compiling valuable manuals; he was an energetic writer for, and editor of, periodical publications; and, we may add, he spent much time in the direct service of the public and of public institutions. A sketch of his life and work down to 1872 was given in the first volume of "The Popular Science Monthly." But he has held so high a place, and has done so much that is valuable since then, and as that biography is probably not now accessible to a great many of our readers, no apology need be offered for reviewing the principal features of Dr. Carpenter's career, and adding, with the account of his later work, such new information as is afforded by the reminiscences which are always brought out by the death of a man who has played an important part.

WILLIAM BENJAMIN CARPENTER was born in Exeter, England, October 29, 1813. His father, the Rev. Dr. Lant Carpenter, was an eminent Unitarian minister, and a writer on theological subjects, who removed to Bristol in 1817. Hence the son's earlier life became so identified with that city that some of his biographers have said that he was born there. The whole family are characterized by ability. Dr. Carpenter's sister, Miss Mary Carpenter, who died a few years ago, was an eminent philanthropist, whose work in relation to the treatment of prisoners, and to questions affecting the well-being of the women of India, entitle her, as Dr. Ray Lankester happily says, to be remembered by future generations with no less gratitude than her brother. His sons are men of mark in the Unitarian ministry, in literature, and in science.

He received his earlier instruction in the school established by his father at Bristol, studying the classics and the principles of physical science, with a preference of taste for the latter class of studies. He intended to become a civil engineer, but, no suitable opening appearing in that profession, he entered upon the study of medicine, in 1828, with Mr. J. B. Estlin, a brother-in-law of Dr. Pritchard, the ethnologist, in connection with which he attended the lectures at the Bristol Medical School. In the winter of 1832 he visited the West Indies in company with Dr. Estlin, who went on a voyage for his health, to re-

WILLIAM BENJAMIN CARPENTER, LL. D., F. R. S.,

President of the British Association for the Advancement of Science.

sume his studies on his return, at Bristol, then at University College, London, and finally in the University of Edinburgh, where he received the degree of M. D. in 1839. His graduating thesis, which gained for him a gold medal, was on "The Physiological Inferences to be deduced from the Structure of the Nervous System of Invertebrated Animals." It attracted considerable attention on account of some peculiar special views advanced in it, and it pointed out the direction which his future studies were destined to take. Previous to his graduation he had been appointed Lecturer on Medical Jurisprudence in the Bristol Medical School. He settled down to practice and married in Bristol; but, in 1844, feeling a distaste, according to Dr. Lankester, for the profession of medicine, he removed to London in order to devote himself entirely to a literary and scientific career. Here he was appointed Fullerian Professor of Physiology in the Royal Institution, and was made a Fellow of the Royal Society; in the next year he became a lecturer in the London Hospital; in 1847 a lecturer on geology in the British Museum, one of the examiners of the London University, and editor of the "British and Foreign Medico-Chirurgical Review"; in 1849, Professor of Medical Jurisprudence at University College; and in 1852, Principal of University Hall.

Dr. Carpenter began the researches with which his name is associated and the publication of results upon them while still quite young. Two books—Sir John Herschel's "Discourse on the Study of Natural Philosophy," and Lyell's "Principles of Geology"—exerted a great influence over his mind while he was a student, and served in a certain sense as models in the execution of the literary part of his work. Dr. Lankester remarks that from the first his work showed the tendency of his mind to seek for large generalizations and the development of philosophical principles. "He was a natural philosopher in the widest sense of the term—one who was equally familiar with the fundamental doctrines of physics and with the phenomena of the concrete sciences of astronomy, geology, and biology. It was his aim, by the use of the widest range of knowledge of the facts of nature, to arrive at a general conception of these phenomena as the outcome of uniform and all-pervading laws. His interest in the study of living things was not therefore primarily that of the artist and poet so much as that of the philosopher, and it is remarkable that this interest should have carried him, as it did, into minute and elaborate investigations of form and structure." Among his earliest contributions was a paper "On the Voluntary and Instinctive Actions of Living Beings." Before he was twenty-five years old he had published articles on "Vegetable Physiology" and "The Physiology of the Spinal Marrow," and a review of that part of Whewell's "History of the Inductive Sciences" which relates to physiology. His first important essay in the study of the nervous system, the special branch of the science to which he more closely devoted his attention, was a review of Noble's "Physiology of the Brain," in which he exposed the unscientific character of the claims of phrenology. In this paper he also extended the idea of reflex nervous function to the centers of sensation and ideation, and enunciated the fundamental notions of "consensual" and of "ideo-motor" action. Curiously Mr. Carpenter's arguments converted the author of the book, Dr. Noble, who in a short time surrendered the principal hypotheses which he had endeavored to enforce in it.

His first systematic work, produced in 1839, was the "Comparative Physiology," or, to cite it by its full title, the "Principles of General and Comparative Physiology, intended as an Introduction to the Study of Human Physiology, and as a Guide to the Philosophical Pursuit of Natural History." This work, which has passed through many editions, and is even now, though out of print, hardly behind the times, is acknowledged to have been when it was first published the best arranged and most clearly written work on physiology in the English language. It was a pioneer and successful effort to deal with the phenomena of animal and vegetable life as parts of a single whole in the manner that is now almost universally done in treating of the science of biology. While residing at University Hall, from 1851 to 1859, he remodeled this work and divided it into two parts: the "Comparative Physiology," comprehending the general biological portion; and the "Human Physiology," consisting of the part relating to the special physiology of man and the higher animals. The "Human Physiology" embodied the most complete and thorough exposition of the subject that had yet been presented, and was particularly remarkable for the manner in which the physiology of the brain and nervous system was treated, and for the introduction of the theories of cerebral localization which have since been elaborated with increasing exactness and remarkable results. The part of the book relating to this branch of the subject, developed and matured by subsequent studies, was published separately in 1874 as the "Principles of Mental Physiology," a book which "Nature," in its review of it, characterized as marking the author as one of those philosophers "who refuse to treat the phenomena of mind as though they were in no way connected with the body through which they find their expression." Rejecting the method of treating mental phenomena as abstracted from their surroundings, Dr. Carpenter based his system on the construction and working of the nervous system. "But while shunning the metaphysical system," the reviewer in "Nature" continues, "he does not adopt the other extreme, the doctrine, we mean, of the thorough materialist, who regards all mental phenomena without exception as the outcome of previous physical causes which necessarily produce certain results. He steers a middle course, inasmuch as, while he advances the theory 'of the dependence of the automatic activity of the mind upon conditions which bring it within the nexus of physical causation,' he yet believes in 'an independent power controlling and directing that activity which we call will.'"

This doctrine of the independence of the will is regarded as one of the distinguishing characteristics of the philosophy of the treatise, running "through the entire work as the one grand exception among a series of physical sequences, interdependent, and standing to each other in the relation of cause and effect, of antecedent and sequent." Another important feature of the book is found in its discussions of the subjects of mesmerism, spirit-rapping, table-turning, and the like, in which the author's philosophical spirit is eminently displayed. He set himself soberly at work to find out what is true in these manifestations, and to verify the facts, and explain on rational grounds those which were susceptible of explanation, while "he did not hesitate to denounce those he thought were due to insincerity or fraud." He found the key to such of the phenomena as are real in what he called ideo-motor action, which he defined to be "the direct manifestations of ideational states, excited to a certain measure of intensity, or, in physiological language, reflex actions of the cerebrum." His observations on this branch of the subject were also published separately in the work "Mesmerism, Spiritualism, etc., historically and scientifically considered."

Dr. Carpenter's appointment to the office of Registrar of the University of London, in 1856, gave him more leisure than he had previously enjoyed to pursue his studies systematically and untrammeled by the drudgery of routine duties; and the fruits of the employment of this leisure are seen in the greater fullness and perfection of his scientific work subsequent to that time. He had already, during most of his residence in London, been occupied with the minute study of the calcareous shells of the *Mollusca*, and this had led him to the regular use of the microscope. One of the earlier fruits of these studies was his book on "The Microscope and its Revelations," a manual most highly prized by all followers of the enchanting study of microscopy, of which the sixth edition was published in 1881. Other fruits of them are to be found in his reports on the microscopic structure of shells, which he presented to the British Association from 1844 onward. In these papers much light was thrown on the structure, which was found to be more complex than had been supposed, and the law of growth of shells. His studies in the *Foraminifera*, which were continued through his life, furnished the occasion for several memoirs in the "Philosophical Transactions," and for an illustrated monograph, which was published by the Ray Society in 1862. One of the most interesting of his studies in this line was that on the structure and development of the *Comatula*, or feather-star, in which he proposed a theory of the nervous function of the axial cords running through the arms of the animal, differing from or contradicting the views commonly held. A re-examination of the structure of the animal, and repetition of his experiments, made some five years ago at the Marine Laboratory of Dr. Dohrn, at Naples, and the experiments of other naturalists, have given confirmation to his opinion. Pertaining to the investigation of the *Foraminifera* and growing out of it, was the part which he took in the discussions respecting the nature of *Eozoön Canadense*, in which he maintained that the fossil in question exhibits the distinctive structure of the shell-substance of the higher *Foraminiferæ*. He was preparing a memoir on this subject, which he left uncompleted at the time of his death.

Dr. Carpenter, with Professor Wyville Thomson, was one of the prime movers of the expeditions for deep-sea research, which have since been so extensively carried on, and have resulted in so great and valuable additions to our knowledge of zoölogy and the physics of the globe. He took part in the earlier expeditions in 1868 and subsequent years, but was not able to go on the Challenger Expedition. He had an important part, however, in collating and formulating the results of the last expedition, and in making them accessible to the understanding of the public. To this series of investigations belong his theories and publications on ocean-currents.

In 1872 Dr. Carpenter was President of the British Association, at its Bristol meeting, and had the pleasure of announcing in his inaugural address the approaching departure of the Challenger on a circumnavigating expedition of at least three years' duration. The subject of his address was "Man as the Interpreter of Nature," and its purpose was to lead the minds of his audience "to the consideration of the mental processes by which are formed those fundamental conceptions of matter and force, of cause and effect, of law and order, which furnish the basis of all scientific reasoning, and constitute the *philosophia prima* of Bacon"; and to show "that those who set up their own conceptions of the orderly sequence which they discern in the phenomena of nature, as fixed and determinate laws, by which those phenomena not only are within all human experience, but always have been and always must be governed, are guilty of the intellectual arrogance they condemn in the systems of the ancients, and place themselves in diametrical antagonism to those real philosophers, by whose comprehensive grasp and penetrating insight that order has so far been disclosed." At the close of his address, having shown how man had arrived at the recognition of the unity of the power of which the phenomena of nature are the diversified manifestations, and how all scientific inquiry now tends toward this point, he declared that the science of modern times had taken a more special direction: "Fixing its attention exclusively on the order of nature, it has separated itself wholly from theology, whose function it is to seek after its cause. In this, science is fully justified, alike by the entire independence of its objects, and by the historical fact that it has been continually hampered and impeded, in its search for the truth as it is in nature, by the restraints which theologians have attempted to impose upon its inquiries. But when science, passing beyond its own limits, assumes to take the place of theology, and sets up its own conception of the order of nature as a sufficient account of its cause, it is invading a province of thought to which it has no claim, and not unreasonably provokes the hostility of those who ought to be its best friends. For while the deep-seated instincts of humanity, and the profoundest researches of philosophy, alike point to mind as the one and only source of power, it is the high prerogative of science to demonstrate the unity of the power which is operating through the limitless extent and variety of the universe, and to trace its continuity through the vast series of ages that have been occupied in its evolution." In harmony with these views, he has maintained the genetic unity of all organic beings, and has had no difficulty in insisting that evolution is compatible with theism, and in fact gives a stimulus to the religious emotions.

Dr. Carpenter retired from the registrarship of London University in May, 1879, on a pension, and was chosen a member of the senate of the institution. Among the most important incidents of his career as registrar is mentioned the fact that he secured for the study of natural science the recognition it has enjoyed at the university, and the important place it has always held in the examinations. Shortly after his retirement a movement was instituted, with Earl Granville, Sir John Lubbock, and Dr. William Smith at its head, to procure a portrait of him to be presented to the university, as a memorial of his labors in its behalf.

Arduously as Dr. Carpenter was engaged in scientific research, he found time to make himself useful and appreciated in public and social life. He took pleasure in making science intelligible to the public, and for this purpose accepted a part in the management of the Gilchrist trust for popular lectures, and delivered lectures in the Gilchrist and Swiney courses. His articles on the zoetrope and other similar toys, in the "Intellectual Observer," are commended for their clearness, and the same quality of style contributed very largely to make his physiological treatises popular. He took the highest interest in social questions, and was always glad to throw the light of scientific knowledge upon them. He was quick to perceive the evils of indulgence in intoxicating liquors, became an advocate of total abstinence, and lectured on temperance, while he afterward concluded that there was a legitimate use for wine. Upon Dr. Ray Lankester, who knew him from his own boyhood, "he always produced the most vivid impression of a man of indomitable energy, who had accepted as the highest duty and keenest delight of his life the promotion, whether by advocacy or by research, of true knowledge." "No man of science," Dr. Lankester says in another notice of him, "could witness without respect and sympathy the ardent devotion of the veteran naturalist to the cause of scientific progress, and the earnest simplicity of his character." Whatever he said when his researches were the subject of conversation "was admirable, and his willingness to meet fairly an antagonist was no less indicative of the true, single-hearted man of science than the almost boyish eagerness with which he would rush into the fray."

From a sketch by a member of his own family, published in the Unitarian paper of London, we learn that he was well versed in literature; that he had a keen relish for political memoirs of his own time; that he took a high view of a citizen's obligations; that he was surprised when in Italy by evincing to himself a susceptibility to the enjoyment of art; that he found unfailing recreation in music; that Nature was to him full of charm and delight; that various qualities made him a genial and ever-welcome companion, trusted for his fidelity; that the dominant conception of his life was that of duty; and that he was rich in family affections.

He was a member of the principal learned societies of his own and other countries; he received the Royal medal of the Royal Society in 1861 and the degree of LL. D. at Edinburgh in 1871, and was elected a corresponding member of the Institute of France in 1873. An illustration of the popularizing tendency of his efforts is given in the fact that the Society of Arts opened one of its life-memberships to him in consideration of the valuable assistance he had afforded it when medals were awarded by it for microscopes to be sold to the public at a cheap rate.

Dr. Carpenter's death, which took place on the 10th of November, 1885, was in consequence of injuries received from an accident which occurred while he was taking a vapor-bath. The lamp of the apparatus being out of order, he used instead a gallipot containing alcohol. In his movements while changing position, he overturned the vessel, and was in consequence severely burned about the body, legs, and face, so that he died about four hours afterward.

SKETCH OF JAMES B. EADS.

THE man who devised and furnished our Government with its first and most useful armored steamboats; who built the St. Louis Bridge; who made one of the shallowest mouths of the Mississippi River permanently navigable for the use of ocean-steamers, and who entertains other practical conceptions as grand as these which, by his logical presentation, have won the unqualified indorsement of the ablest of his professional brethren, has a most evident title to recognition in scientific biography.

James Buchanan Eads was born in Lawrenceburg, Indiana, May 23, 1820. "He very early," says Dr. Boynton, in the "History of the Navy during the Rebellion," "evinced such a love of machinery as attracted special notice." When only eight years old, he watched with the greatest interest all the machinery to which he had access. When nine years old the family removed to Louisville. The engine on board the boat excited so much admiration and wonder that the engineer was induced to explain to him the principal parts of the machine. So well did the lad profit by this one lesson in steam-engineering that in little more than two years after he constructed a miniature engine which was worked by steam. When about ten years old, his father fitted for him a small workshop, and there he constructed models of saw-mills, fire-engines, steamboats, steam-engines, electrical and other machines. One of the pastimes of his childhood was to take in pieces and put together again the family clock, and at twelve years he was able to do the same with a patent-lever watch, with no tools but his pocket-knife. When thirteen, misfortune overtook his father, and he had to withdraw from school and work his own way. His parents went to St. Louis in 1833 and he went with them. The steamer was burned in the night on the way there, and he landed barefooted and coatless, on the very spot now covered by the abutment of the great steel bridge which he designed and built. The only opening in the way of business that offered was to sell apples on the street, and by this means, for a few months, he sustained himself and assisted in supporting his mother and sisters. In time he obtained a situation with a mercantile firm, where he remained for five years. One of the heads of the house having an excellent library, gave him access to it, and he used his opportunity well to study subjects bearing upon mechanics, machinery, civil engineering, and physical science. In 1839 he obtained employment as a clerk or purser on a Mississippi River steamer. He again made the best use of his opportunity to acquire that complete knowledge of the great river which he was afterward able to turn to such good account in the noble enterprises he so fortunately carried into effect. In 1842 he constructed a diving-bell boat to recover the cargoes of sunken steamers. This was followed with a boat of larger tonnage, provided with machinery for pumping out the sand and water and lifting the entire hull and cargo of the vessel. A company was formed to operate this device, and it soon had a business that covered the entire Mississippi River, from Balize to Galena, and even branched into some of its tributaries. By his methods, a great many valuable steamers were set afloat and restored to usefulness which it would not previously have been possible to save, as they would have been buried very soon beneath the river-sands. It was while engaged in this business that he gained a thorough knowledge of the laws which control the flow of silt-bearing rivers, and of the Mississippi he was able to say years afterward that there was not a stretch in its bed fifty miles long, between St. Louis and New Orleans, in which he had not stood upon the bottom of the stream beneath the shelter of the diving-bell.

In 1845 he sold out his interest in this company and established in St. Louis the first manufactory of glass-ware west of the Ohio River.

Two years later this enterprise culminated in financial disaster, and left him, at the age of twenty-seven, burdened with debts to the amount of twenty-five thousand dollars. He then returned to the business of raising steamers, removing obstructions from the channel, and improving the harbor of St. Louis. By the great fire of 1849, twenty-nine steamers were burned at the landing of that city, and most of these wrecks had to be removed by him. The capital with which he started again at this business was supplied by his creditors, and amounted to only fifteen hundred dollars. Ten years later he had increased this modest sum to nearly half a million dollars, and had long previously paid off his creditors in full.

His first undertakings in this peculiar and instructive study of hydraulics occurred while he was constructing the first diving-bell boat, not then completed. A barge loaded with about a hundred tons of pig-lead was sunk upon the rapids of the Mississippi River, near Keokuk, in fifteen feet of water. A contract was made for the recovery of this lead. He had had no experience whatever with the submarine armor, or diving apparatus of any kind; but, engaging a diver from the lakes who was familiar with it, with an armor, an air-pump, and a sailor skillful in the use of rigging, he started—at that time only twenty-two years of age—to the scene of the wreck. Obtaining a barge, this was promptly anchored over it, and preparations made for the diver to go to work; but the current was found so exceedingly rapid that it was impossible to use the armor with any safety. A belt around the diver's waist was attached by a cord to the bow of the boat to hold him against the current, and a ladder procured on which the diver undertook to descend, but it was impossible for him to control his body in the current. Determined not to be baffled, Mr. Eads immediately visited the town of Keokuk and purchased a forty-gallon whisky-barrel, with which to improvise a diving-bell. With several pigs of lead secured around one end of the barrel by a net-work of ropes, and with that head taken out, a block and tackle attached to the net-work at the other end, and a temporary derrick erected, he was soon prepared to commence the recovery of the cargo. But the diver demurred and would not descend in this dangerous-looking apparatus. Mr. Eads then set an example which he has followed throughout all his varied experience as an engineer—which was, never to ask a man in his employ to go where he was unwilling to trust his own life. The bell thus suspended was held against the current by a rope which led up to the bow of the barge, and a strap across the lower end of the barrel was used as the seat for the diver in it. He at once got into the diving-bell and ordered his men to lower him down. He had a trace-chain attached to a lead-line, the lower end of the trace-chain having a ring in it, and with this he was readily enabled to form a loop, which was placed over one of the pigs of lead, and at a given signal it was hoisted up. A small cord sufficed to draw it back to him while he was still in the bell; and in this manner a number of the pigs, weighing seventy pounds each, were recovered before he started to come up—the air-pump all the time supplying him with air. But, in the mean time, having cleared the space beneath the bell, the guy-line moved it farther and farther up-stream, in compliance with his signals, and instead of the line being slacked out again when his men commenced raising the bell, it was held so far forward that the derrick capsized, having no guy to hold it in the opposite direction. His assistants seized the block and tackle and pulled the whisky-barrel up to the surface of the water by hand. But it was so weighted with the lead around it that they could not raise it higher. Not knowing what was the matter, he waited patiently, the air-pump running with redoubled velocity, supplying him with plenty of air. He soon saw the fingers of a man under the chime of the barrel, and, recognizing this as an invitation, he seized the man's hand and got out from under the barrel, much to the delight of all on board. The derrick was then secured against any possible catastrophe occurring again, and, after a number of successful trips to the bottom, the diver was content to do the remainder of the work.

In 1856 Mr. Eads made a proposition to Congress to keep the channels of the Mississippi, Missouri, Ohio, and Arkansas Rivers clear of snags, wrecks, and other obstructions for a term of years. A bill embodying his plans was passed by the House of Representatives, but failed in the Senate for want of action by that body.

In 1857 his health compelled him to retire from business, and four years later he was called upon to render the most signal and brilliant services to his country in its time of extreme need. It was on the 17th of April, 1861, three days after the surrender of Fort Sumter, when Attorney-General Bates wrote to him from Washington: "Be not surprised if you are called here suddenly by telegram. If called, come instantly. Under a certain contingency it will be necessary to have the aid of the most thorough knowledge of our Western rivers and the use of steam on them, and in that event I have advised that you should be consulted."

The dispatch came shortly after the letter. Mr. Eads went immediately to Washington, and, after consulting with the President and Cabinet, prepared the plan he was requested to submit to them for placing gunboats on the rivers, with suggestions as to the kind of boats best fitted for the service, and in regard to the location of batteries to be erected at several points on shore. Shortly afterward he was appointed, with Captain (afterward Rear-Admiral) John Rodgers, United States Navy, to carry into effect the recommendations which he had made, and at once to improvise three war-vessels for service at Cairo. These were the Conestoga, Tyler, and Lexington, and were the first of the large fleet that afterward covered the Mississippi River. The Quartermaster-General issued proposals soon after for the construction of seven ironclad gunboats. These were designed by Mr. Eads, and he undertook to build them in sixty-five days—a short enough time under the best of circumstances; but business was then disorganized and all industrial enterprises in a chaotic condition. The materials with which the work was to be done had to be manufactured. Yet these seven heavily-plated vessels of about six hundred tons each were all finished according to contract, and another one still larger, a snag-boat, was by alterations and heavy plating made ready with the others for their armament. "Thus one individual put into construction and pushed to completion within a hundred days a powerful squadron of eight steamers aggregating five thousand tons, capable of steaming at nine knots per hour, large, heavily armed, fully equipped, and all ready for their armament of one hundred and seven large guns. The fact that such a work was done is nobler praise than any that can be bestowed by words."*

In 1862 Mr. Eads was commissioned to build six more armored iron gunboats, four of which were much larger than any of the eight preceding ones. These were likewise after his own designs, four of them having two turrets each and the smaller ones one turret each. These turrets were a modification of the Ericsson turrets, the Government insisting upon these being placed upon them. He was, however, permitted to place one turret on each of two of these large gunboats, after his own design, and costing about thirty-five thousand dollars each, but on the written condition that they should be replaced by Ericsson turrets if they were not found satisfactory. The guns in these two turrets were worked by steam, and this was the first time in the history of artillery-practice when heavy guns were manipulated wholly by steam. These vessels all proved to be of lighter draught than had been stipulated, so that it was possible to add from half to three quarters of an inch to their armor; and three of them exceeded very considerably the contract speed. While these fourteen ironclads were under way, Mr. Eads also had the construction of four heavy mortar-boats and seven tin-clad or musket-proof boats. The kind of ironclads that Mr. Eads designed and constructed and the kind of work they did are recorded in the history of Grant and Halleck's campaigns, and of Farragut's capture of Mobile.

In the construction of a steel-arch bridge at St. Louis, on which he was engaged from 1867 to 1874, Mr. Eads had to deal with problems which had not before confronted an engineer. The central arch of this structure has a clear span of five hundred and twenty feet, and is pronounced, by the "British Encyclopædia," the finest specimen of metal-arch construction in the world. The side arches are five hundred and two feet each in span. All of the piers, in consequence of the shifting deposits beneath the river-bed, were sunk clear through to the bed-rock. This required them to be sunk much deeper than

* Boynton's "History of the Navy during the Rebellion."

any piers ever built, and through a medium of the most treacherous character. New plans had to be devised to secure success. One pier, weighing forty-five thousand tons, was sunk to a depth of one hundred and thirty-six feet below high-water mark through ninety feet of sand and gravel; and another one, weighing forty thousand tons, to one hundred and thirty feet through eighty feet of deposit. The loss of life which occurred in the caisson of the east pier resulted from the fact that the situation at such a depth, with the air-pressure it was necessary to endure, was entirely new, and there was no recorded experience by which operations could be guided safely. The erection of the arches developed new problems. The arches had to be designed about two and a half inches longer than they are in their present position, because of the contraction which their weight causes throughout the arch. Each half of the arch was built out from the pier and suspended by guys passing through heavy masts erected on each pier, and the central tubes had to be specially fitted for insertion. The suggestion was made by his chief assistant to contract the tubes by boxing them up and covering them with iron. This Mr. Eads disapproved of, and devised telescopic tubes for the center of the arch which could be shortened by an internal right and left hand screw-plug, and afterward extended by powerful levers to rotate this plug, steel bands being also provided to cover the plug, flush with the outside of the tube, when the tubes were properly distended. During his absence in London, the chief assistant, confident of his ability to close them with ice, and, having been left with full authority, undertook to do so; but the attempt proved a failure after a trial of eight or ten days, and the telescopic tubes, which Mr. Eads had prepared, were then inserted without difficulty.

In an address delivered at the opening of this bridge, July 4, 1874, Mr. Eads revealed that confidence in his resources and investigations which probably furnishes one of the keys to the secret of his success in this and in his other enterprises. This secret consists in the fact that his courage is always equal to his convictions. Everything, he said, on this occasion, which prudence, judgment, and the present state of science could suggest to him and his assistants had been carefully observed in its design and construction; every computation involving its safety had been made by different individuals, thoroughly competent to make them; they had been carefully revised, time and again, re-examined, verified, until the possibility of error nowhere existed.

A similar confidence was displayed in his plans for deepening the mouth of the Mississippi by jetties, in which he was opposed by nearly all of the United States engineers, and by a commission of seven of them. The commission in 1874 proposed to avoid the bars by building a canal from Fort St. Philip to Breton Bay. Mr. Eads's plan was to make the river itself deepen a channel through them. Congress naturally inclined to adopt the advice of its official experts, but Mr. Eads had faith enough in his plan to propose to do the work at his own expense and wait for his pay until he had demonstrated its success. It was hard to get permission to make even the experimental application of his views thus so liberally proposed; but a bill was finally passed to allow him to attempt the improvement of the South Pass, the smallest of the three, and not the one he had selected, and the depth on the bar of which was only eight feet. The cost of the work was to be five and a quarter million dollars; only half a million was to be paid after a channel twenty feet deep by two hundred feet in width had been secured, another half million after a channel twenty-two feet deep, and other sums on the obtaining of channels of twenty-six and twenty-eight feet depth respectively; but, as a guarantee that the maintenance of the channel should not cost more than one hundred thousand dollars a year, the final million of the whole sum was to be withheld until a channel of thirty feet maximum depth had been kept throughout during twenty years. Congress, however, deeming these terms unnecessarily severe, with remarkable unanimity voted to pay him one and three-quarter million dollars in advance of his contract terms, after he had secured twenty-two feet depth.

The conception of the plan of the jetties was based upon a knowledge of the fact that the Mississippi River is a transporter of solid material, almost all of which is held in suspension by the mechanical effect of the current, and that the quantity of the matter which it is able to carry increases with the square of the velocity. The current of the river is caused by the fall of the water from a higher to a lower level; that is, by the force of gravity. The element which resists the current is the friction of its bed; this friction does not follow the law of solids, but increases or diminishes exactly as the width of the bed or wetted perimeter of its cross-section is increased or diminished: hence, if the stream be contracted, where it is too wide, to one half its width, one half of the frictional resistance will be gone, and the current will be more rapid, and therefore more able to carry a larger load of sediment. This it immediately takes up from its own bed and thus causes a deepening. The result of the application of the jetty system to the South Pass has been a triumphant justification of its author's views.

On the 8th of July, four years after he commenced the work at the jetties, the United States inspecting officer reported that the maximum depth of thirty feet had been secured throughout the jetty channel, and that the least width of the twenty-six-feet channel through the jetties was two hundred feet. The balance due Mr. Eads upon his contract was then paid to him, and the million that was to be held as security for maintenance was considered as earned, and placed at interest for his benefit. The current of the river has maintained this depth ever since. The cost of the jetties was about half of the estimated cost of the proposed canal.

Mr. Eads had not commenced the jetties before he turned his attention to the improvement of eleven hundred miles of the Mississippi throughout its alluvial basin by the jetty system. On March 15, 1874, in a letter to the Hon. William Windom, chairman of the Senate Committee on Transportation Routes to the Seaboard, the first outline of this novel plan was suggested.

In his review of the United States Levee Commission, February 19, 1876, Mr. Eads said :

"By the under-charge theory of the Delta Survey Report, caving banks are attributed to the direct action of the current against them, by which strata of sand underlying those of clay are supposed to be washed out. This is not correct. If the water be charged with sediment to its normal supporting capacity, it can not take up more unless the rate of current be increased. Caving banks are caused wholly by the alternations in the velocity of the current. Alternations are inseparable from a curved channel, because the current in the bend is usually more rapid than on the point ; but, if the channel be nearly uniform in width, the caving caused by the curves will be very trifling. And, in proof of this, many abrupt bends exist in the lower part of the river where the whole force of the current has set for years directly against them without any important caving of the banks. The bend at Fort St. Philip is a notable instance, the great difference in the width of the flood-channel constituting the real cause of the destruction and caving of the banks. This tends to great irregularities in the slope of the flood-line, and, consequently, great changes in current velocity by which a scouring and depositing action are alternately brought into very active operation. The whole of the river below the Red River proves this ; caving banks are much less frequent there than above, because the flood width of the river is far more uniform. A correction of the *high-water channel*, by reducing it to an approximate uniformity of width, would give uniformity to its slope and current, almost entirely preventing the caving of its banks, and through its present shallows, which now constitute the resting-places for its snags, there would be a navigable depth, in *low water*, equal to that which now exists in its bends. By such correction the flood-slope can be permanently lowered, and in this way the entire alluvial basin, from Vicksburg to Cairo, can be lifted, as it were, above all overflow, and levees in that part of the river rendered useless. *There can be no question of this fact, and it is well for those most deeply interested to ponder it carefully before rejecting it ; for the increased value given to the territory thus reclaimed can scarcely be estimated.*"

Two years later, in a review of Humphreys and Abbott's "Report on the Physics and Hydraulics of the Mississippi River," published in Van Nostrand's "Engineering Magazine," Mr. Eads elaborated this plan, and combated the declaration that the bed of the river is formed of blue clay and will not erode unless very slowly under the effect of the current, and likewise exposed the fallacy of the declaration that there is no relation between the quantity of sediment carried in the water and the velocity of its current.

Mr. Eads thus clearly outlined, in 1874, 1876, and 1878, one of the most magnificent plans which hydraulic engineering has ever undertaken. It is not simply to save thirty thousand square miles of land as rich as the Delta of Egypt from devastating inundations, but to extend deep water from the Gulf of Mexico to the mouth of the Ohio, into the very heart of the Mississippi Valley, while permanently locating this magnificent channel by practically putting an end to the caving of its banks. During the period we have referred to, Mr. Eads delivered addresses upon this subject in the chief cities of the river, published elaborate essays in which it was fully explained, and defended it against all attacks, until finally, in 1879, Congress authorized the creation of a commission to consider this plan, which is known as the "jetty system." The "outlet system" and the "levee system" were also examined by it, and in 1880 it reported in favor of the "jetty system," and recommended its adoption by Congress in its report, February 17, 1880. Mr. Eads was a member of the commission for two or three years. During this period, several million dollars were voted by Congress to carry out the plan, which will be found described in the report referred to, as agreeing substantially with the quotations we have made. Two reaches of the river, Plum Point, twenty miles long, and Lake Providence, thirty-five miles long, were selected for improvement; the low-water depth in the first reach was only five feet, the other reach (four hundred miles below) had a depth of only six feet. The permeable contraction-works, constructed of piles and willows, which had been first used by Mr. Eads at the South Pass several years before, were put in position for one season in the period between two floods, and the effect produced by the works during the first flood that followed was simply marvelous. The depth was increased through the upper reach to twelve feet at low water, and through the lower reach to fifteen feet, and scores of millions of cubic yards of sediment were deposited between them by the checking of the current by the permeable works. Thus new shore-lines of an approximately uniform width were developed. In some places the deposit was thirty feet deep.

Mr. Eads was, during the time of this construction, in bad health, and for some time absent from the United States. Owing to the charge made by several prominent friends of the river (members of the Senate and House), that the commission had abandoned the leading feature of the system, the contraction-works, and had changed it to a costly system of bank-revetments, and the public declarations of Mr. Eads to the same effect, no further appropriations were made at the last session of Congress to continue this magnificent work; enough has been done, however, to show the entire practicability of the plan.

Mr. Eads claims that this system of improvement designed by him is, in several respects, wholly different from any ever before proposed for the treatment of a river; it is, however, only applicable to rivers flowing through alluvial deposits.

The grandest work, however, contemplated by Mr. Eads, is the ship-railway which he proposes to construct across the Isthmus of Tehuantepec, for the transportation of large ships fully laden from ocean to ocean. This he holds to be entirely practicable—because the railway can be built wherever the canal can, at one half the cost of the canal with locks, or one quarter the cost of one at tide-level; because it can be built in one third or one quarter of the time needed to build a canal; because four or five times the speed practicable on a canal can be secured; because more vessels can be carried in a day over the railway than through the canal; because the capacity of the railway can be increased to suit increased needs without disturbance; because it will cost less to maintain and operate it than to maintain and operate a canal; because it can be built and operated where the canal can not be; because more accurate estimates can be made of the cost and time needed for its construction; and because its location is the very best of all those which are proposed on the American Isthmus. It is not generally known, but it is nevertheless true, that the location of the ship-railway and that of the Panama Canal are about twelve hundred statute miles apart, the whole immense territory of Central America lying between the two. It is, therefore, far superior in climate and in position to any other location.

Besides these works, Mr. Eads has, at the request of the Governments and individuals particularly interested, examined and reported upon the bar at the mouth of the St. John's River, Florida, the improvement of the Sacramento River, the improvement of the harbor of Toronto, the improvement of the port of Vera Cruz, the improvement of the harbor of Tampico, the improvement of the harbor of Galveston, and the estuary and port of the Mersey, England. He was President of the St. Louis Academy of Science for two terms, and made an inaugural address in which was embodied a review of the recent achievements of science, and, in another, the present knowledge of the laws of light. In 1881 he made an extemporary address before the British Association at York, upon the improvement of the Mississippi, and also upon the Tehuantepec Ship-Canal, which were, by unanimous vote, ordered to be embodied in its report of the proceedings; and in June, 1881, he was awarded the Albert Medal of the British Society of Arts, in token of its appreciation of the services he had rendered to the science of engineering—he being the first American upon whom this medal had been conferred. It is now his purpose to devote the remaining energies of his life, until the scheme is an accomplished fact, to the prosecution of the Ship-Railway.

EDITOR'S TABLE.

BEECHER'S POSITION ON EVOLUTION.

TWO great standards of truth have prevailed in the world; truth according to nature and truth according to theology. Truth according to nature has been held as of little moment, because all its consequences are temporal and transitory; but truth according to theology has been held as of infinite importance, because salvation and the interests of an immortal destiny depended upon it. There was, therefore, but little chance for getting up much interest in the truth of things natural so long as the theological standard of truth was supreme. Galileo made a book stating the evidence of the Copernican system of astronomy according to the facts of nature; but he was summoned before the inquisitorial court to answer the charge of heresy for not judging of the scheme of the planetary motions by the standard of theological authority. Truth according to nature in those days went for very little in comparison with truth according to the supernatural. Theological ideas were in the minds of everybody, were held of transcendent importance, and everything in the shape of new knowledge was first brought to the test of agreement with authorized religious doctrine.

Two or three centuries have made great changes in this matter. The theological standard has been lowered, and a much higher value is set on the truth which agrees with nature; but multitudes of minds are still dominated by theological conceptions, and when new ideas are proposed instead of asking whether they agree with the facts or are true to the nature of things, the first question is, as it was three hundred years ago, How do these ideas agree with prevailing religious opinions? The illustrations of this survival of the theological spirit and methods are still numerous, and a fresh example has recently come to our attention which will well serve to bring out the point we have in view in the present article. It consisted of a vigorous attack on Mr. Beecher's book, "Evolution and Religion," which appeared in the "Commercial Advertiser" of November 20th. The point of view is thoroughly mediæval, the writer seeming to care but very little as to whether evolution is true or not, but to be profoundly concerned about theology's relation to it. The writer condemns Mr. Beecher for refusing to judge of the doctrine of evolution on the basis of its agreement or non-agreement with the old middle-age standards of religious dogma. He says: "Of course Mr. Beecher, like anybody else, may put what construction he pleases on the doctrine of evolution, and he may put a construction to suit him on the doctrines of theology, and in that way patch up a sort of reconciliation: and that is precisely what he does. . . . At the same time he contrives a religion which is certainly not the religion of the fathers, or of the martyrs, or of the ancient confessors, or of any of the accepted symbols of the Church." From which we are to infer that the theology of the fathers and of the martyrs and of the ancient confessors or old cast-iron middle-aged orthodoxy, is to be taken as the standard of truth, and the doctrine of evolution judged by its agreement with that standard. That the writer should argue that the doctrine of evolution is materialistic and atheistic is quite a matter of course; but what we wish to call attention to here is, that he seems to have but little more care as to whether this doctrine is true to the realities of nature than had the old inquisitors in relation to the new astronomy. Indeed, toward the close of his article he has the following contemptuous reference to this point: "We are not going to argue here the truth or falsehood of the unverified and unverifiable hypothesis which is palmed upon us in the name of science." Still, we think that the question of "truth or falsehood" in so important a case is one that might well have been settled first. If the theory of evolution, as the writer declares, "has been reached in utter defiance of the canons of scientific method," it would have been well to show this at the outset. Besides, if the doctrine is an imposture, "which is palmed upon us in the name of science," it would be interesting to have it pointed out by what extraordinary hocus-pocus the scientific men of the present age have been imposed upon in accepting it.

To us the chief interest of Mr. Beecher's position, assumed in his recent books, is as a register of the rising influence and increasing power of scientific ideas and the corresponding decline of theological authority. He has passed far beyond the stage in which he asks first whether new ideas agree with old creeds. Although a professed theologian, he has so thoroughly entered into the spirit and method of modern science as to recognize that the supreme question in this case is whether the doctrine of evolution is an expression of the truth of nature. Mr. Beecher has by no means repudiated theology, but he has taken the great step of subordinating it to the standards of truth established by investigation and the study of the order and economy of the existing world. The old notion of two sets or systems of truth, one of which has claims of a special sacredness and superiority, while the other is profane, secular, and of merely human origin, and therefore of inferior rank, we understand him to repudiate. He finds the sacredness of authority in the truth itself, and none the less because man discovers and establishes it by his own faculties. Mr. Beecher, therefore, represents in an eminent way that vast change or revolution of modern thought which gives a higher value and a nobler significance to the study of nature and the revelation of the truths of nature. Nor in thus giving his highest allegiance to natural truth as disclosed by the workings of the human mind can he be said to have rejected religion or left the religious sphere. Holding firmly to theism, he simply maintains that the truth and order and harmony of nature are the highest manifestations of the attributes of God.

Mr. Beecher reconstructs the old theology, rejecting large portions of it which have formerly been held as essential, and reshaping what remains so as to bring it into better agreement with modern scientific ideas. As an honest and conscientious man he found no escape from entering upon this work. Only as an indifferentist, or a trifler, or a theologian enslaved to his traditions, could he recognize the great changes wrought by modern science, without any concern for those readjustments of human belief which have become inevitable. His book is full of evidences of that sincerity and earnestness of feeling upon the subject which have impelled him to undertake the task of working out the religious bearings of the doctrine of evolution. He saw that it had taken root in the best intelligence of the civilized world. There was no blinking or evasion of the facts that had to be met. The strong men of all nations who give their lives to the study of nature, the devotees of research, and the investigators of original truth in all departments of natural phenomena had come to agreement over this great principle with a rapidity and a unanimity such as has never before been seen in the history of science. There had been a vast accumulation of observations, facts, and principles in every department of research which defied explication and organization until the law of evolution was grasped and applied to them, and, under the light it afforded, the work of research went on with increasing fruitfulness and success. The doctrine of evolution was not merely acknowledged, but it became a new guide to the discovery of truth, which is the highest possible attestation that could be given of its verity. Nor was it by any means a mystery of experts continued to laboratories of which ordinary people could know nothing and must take on authority. Its illustrations and proofs constantly multiplied in those common spheres of thought with which intelligent people are familiar, so that the current literature of the time was full of it. Mr. Beecher saw that the doctrine was not only accredited by a very large number of the ablest minds of the age as an established truth, but he had himself been a student of the subject in his own field of labor, and he found it of invaluable service in that revision of beliefs and opinions which was a part of his responsible duty as an independent public teacher. In broadly accepting and comprehensively applying the new doctrine, Mr. Beecher gives a powerful impulse to theological reform, for, in the further winnowing of religious opinions, only those will stand which are found vitally rooted in the truths of nature; and, from this point of view, the acceptance of the doctrine of evolution by the religious mind will be the most important step yet taken in renovating theology by ending its antagonism with the order of natural truth, and by making "the solid ground of nature" its lasting and unshakable foundation.

LITERARY NOTICES.

Louis Agassiz: His Life and Correspondence. Edited by Elizabeth Cary Agassiz. In two volumes, pp. 794. Boston: Houghton, Mifflin & Co. Price, $4.

Mrs. Agassiz began the preparation of this extremely interesting biography with the simple purpose of preserving the facts, letters, and journals bearing upon it from dispersion and final loss. But, as the work grew in her hands, she says she began to feel that an intellectual life, marked by such unusual coherence and unity of aim, might serve as a stimulus and an encouragement to others. And, for this reason, she at length decided to place it before the general public. The first volume contains a portrait of Agassiz at the age of nineteen, and several other interesting illustrations connected with his birthplace and early life. The narrative in this volume covers the European portion of Agassiz's life, about which little is known in this country. It is woven together from family papers, and the contributions of fellow-students and others who knew Agassiz intimately at one period or another of his early career. A brother of Professor Agassiz, who survived him several years, took the greatest interest in preserving whatever concerned his scientific career, and this brother furnished Mrs. Agassiz with many papers and documents concerning his earlier life. After the brother's death the work was continued by a cousin, Mr. Auguste Mayor, who also selected from the glacier of the Aar, "at the request of Mr. Alexander Agassiz, the bowlder which now marks his father's grave."

Louis Agassiz had no other teacher than his parents for the first ten years of his life. "Having lost her first four children in infancy, his mother watched with trembling solicitude over his early years." She understood that his love of nature was an intellectual tendency, and throughout her whole life, as well in the work of his manhood as in the sports of his childhood, she remained his most intimate friend. He survived her but six years. When a very little fellow he had his collection of fishes, and the vignette represents the stone basin behind the parsonage, into which water from a spring was always flowing, and which was Agassiz's first aquarium. He had various pets, whose families he reared with the greatest care. "His pet animals," we are told, "suggested questions to answer, which was the task of his life." The story of his school-life, from the age of ten to seventeen, is briefly told, but leaves the distinct impression of a boy with a settled purpose. After spending two years at the medical school in Zürich, Agassiz went to the University of

Heidelberg in the year 1826, at the age of nineteen. It is not easy to make citations from a book of such uniform interest; but his student-life at Heidelberg, and afterward at Munich, as gathered from various passages in this history, has a peculiar fascination. In one of the first acquaintances made by him at this time, Agassiz found a life-long friend—

and in after-years a brother. Professor Tiedemann, by whom he had been so kindly received, recommended him to seek the acquaintance of young Alexander Braun, an ardent student and especial lover of botany. At Tiedemann's lecture, the next day, Agassiz's attention was attracted by a young man who sat next him, and who was taking very careful notes, and illustrating them. There was something very winning in his calm, gentle face, full of benevolence and intelligence. Convinced, by his manner of listening to the lecture, that this was the student of whom Tiedemann had spoken, Agassiz turned to his neighbor, as they both rose at the close of the hour, and said, "Are you Alexander Braun?" "Yes. Are you Louis Agassiz?" . . . The two young men left the lecture-room together, and from that time their studies, their excursions, their amusements, were undertaken and pursued together. . . . Braun learned zoölogy from Agassiz, and he in turn learned botany from Braun.

In a letter of young Braun to his parents, written at this time, he says:

In my leisure hours I go to the dissecting-room, where, in company with another young naturalist, who has appeared like a rare comet on the Heidelberg horizon, I dissect all manner of beasts, such as dogs, cats, birds, fishes, and even smaller fry, as snails, butterflies, caterpillars, worms, and the like. . . . I sometimes go with this naturalist on a hunt for animals and plants. Not only do we collect and learn to observe all manner of things, but we exchange views on scientific matters in general.

And he adds, concerning Agassiz's attainments at this time:

I learn a great deal from him, for he is much more at home in zoölogy than I am. He is familiar with almost all the known mammalia, recognizes the birds from far off by their song, and can give a name to every fish in the water. In the morning we often stroll together through the fish-market, where he explains to me all the different species. He is going to teach me how to stuff fishes; and then we intend so make a collection of all the native kinds. Many other useful things he knows; speaks German and French equally well, English and Italian fairly, is well acquainted with ancient languages, and studies medicine besides. . . . To utilize the interval spent in the time-consuming and mechanical work of preparing specimens, pinning insects, and the like, we have agreed that, while one is employed, the other shall read aloud. In this way we shall go through various works on physiology, anatomy, and zoölogy.

They spent their vacations together; "drew, studied, dissected, arranged specimens, discussed theories with their young brains teeming about the growth, structure, and relations of animals and plants." Another young botanist, Karl Schimper, was taken into this Heidelberg intimacy, and the three were inseparable in their studies. At one time Agassiz was kept at home in Switzerland by sickness, but the letters passing between these fellow-inquirers were remarkable. Here is a set of questions propounded by Agassiz to Braun and Schimper at Heidelberg. He was studying the fishes of the Swiss lakes and trying to catalogue them, and he says:

As I am on the chapter of fishes, I will ask you—1. What are the gill-arches? 2. What the gill-blades? 3. What is the bladder in fishes? 4. What is the cloaca in the egg-laying animals? 5. What signify the many fins of fishes? 6. What is the sac which surrounds the eggs in bombinator obstetricians? [a creature about which there had been former correspondence].

Braun, on his part, writes to Agassiz: "On my last sheet I send some nuts for you to pick, some wholly, some half, others not at all cracked." The following are some of the mooted questions:

1. Where is the first diverging point of the stems and roots in plants, that is to say, the first geniculum?
2. How do you explain the origin of those leaves on the stem which, not arising from distinct geniculi, are placed spirally, or scattered round the stem?
3. Why do some plants, especially trees (contrary to the ordinary course of development in plants), blossom before they have put forth leaves (elm-trees, willow-trees, and fruit-trees)?
4. In what succession does the development of the organs of a flower take place—and their formation in the bud? (compare campanula, papaver).
5. What are the leaves of the spergula?
6. What are the tufted leaves of pine-trees?
7. What is individuality in plants?

It matters not that most of these problems were solved long ago; they no less illustrate the action of these young minds in carrying forward their fruitful studies. It is to these two botanists, Braun and Schimper, that botany owes the discovery of the law of Phyllotaxis which is hinted at in the first of the above questions. We next find the three friends established at Munich, attending the lectures of Dollinger, Martius, Schelling, Oken, the latter of whom was extremely friendly with them, inviting them once a week to his house, where they listened to scientific papers or discussed scientific matters. They took tea once a week with Professor von Martius, while with Döllinger they were still more intimate. "Not only did they go to him daily, but he often came to see them, bringing botanical specimens to Braun, or looking in upon Agassiz's breeding experiments, in which he took the liveliest interest, being always ready with advice and practical aid. The fact that Agassiz and Braun had their room in his house made intercourse with him especially easy. This room became the rendezvous of all the aspiring, active spirits among the young naturalists at Munich, and was known by the name of 'The Little Academy.' . . . The friends gave lectures in turn on various subjects, especially on modes of development in plants and animals. These lectures were attended not only by students, but often by the professors." In a letter to his father, Agassiz describes his life at this period as exceedingly pleasant. He says:

When our lectures are over, we meet in the evening at Braun's room or mine, with three or four intimate acquaintances, and talk of scientific matters, each one in his turn presenting a subject which is first developed by him and then discussed by all. These exercises are very instructive. As my share, I have begun to give a course of natural history, or rather of pure zoölogy. Braun talks to us of botany, and another of our company, Mahir, who is an excellent fellow, teaches us mathematics and physics in his turn. In two months Schimper will join us and become our professor of philosophy. Thus we instruct each other, learning what we teach more thoroughly because obliged to demonstrate it. Each session lasts two or three hours, during which the professor in charge retails his merchandise without aid of notes or book. You can imagine how useful this must be in preparing us to speak in public and with coherence; the experience is the more important, since we all desire nothing so much as sooner or later to become professors in very truth.

Again, in writing to his father, Braun says of these private lectures:

Sometimes Agassiz tries to beat French rules and constructions into our brains, or we have a lesson in anatomy, or I read general natural history aloud to William Schimper. By-and-by I shall review the natural history of grasses and ferns, two families of which I made a special study last summer. Twice a week Karl Schimper lectures to us on the morphology of plants. He has twelve listeners. Agassiz is also to give us lectures occasionally on Sundays upon the natural history of fishes.

An artist who was already in the employ of Agassiz, and who afterward made the illustrations of his works upon fossil fishes, describes Agassiz's life and surroundings at this time as follows:

He never lost his temper, though often under great trial. . . . His studio was a perfect German student's room. It was large, with several wide windows; the furniture consisted of a couch and about half a dozen chairs, besides some tables, for the use of his artists and himself. Alexander Braun and Dr. Schimper lodged in the same house and seemed to me to share his studio. Being botanists, they too brought home what they collected in their excursions, and all this found a place in the atelier, on the couch, on the seats, on the floors. Books filled the chairs, one alone being left for the other artists, while I occupied a standing desk with my drawing. No visitor could sit down, and sometimes there was little room to stand or move about. The walls were white, and diagrams were drawn upon them, to which by-and-by we artists added skeletons and caricatures. In short, it was quite original.

The second volume is devoted to Agassiz's life in America. The frontispiece is a portrait taken at the age of fifty-five, and bringing at once to mind the features so well known to multitudes of people in all parts of the country. Besides the vignette, showing us the laboratory at Nahant, there is a view of the cottage at Nahant, of the Museum of Comparative Zoölogy, a portrait bust by Powers, and a view of Penikese.

Scientific Theism. By Francis Ellingwood Abbot, Ph. D. Boston: Little, Brown & Co. Pp. 219. Price, $2.

This work is an attempt at developing theism from science and the scientific method. Dr. Abbot criticises nominalism and conceptualism, and argues for a noumenism in which every phenomenon is, as far as it goes, a real revelation of the noumenon. He holds that the mind perceives true relations in nature, and that therefore to the extent to which human knowledge has gone it forms a part, however small, of that contained in the Divine Mind. The theory of the unknowable the author rejects, holding that absolute knowledge of a thing would consist in knowing the sum of its relations to all other things in the universe.

Dr. Abbot argues from the intelligibility of the universe to its intelligence; and hence, since it is all-inclusive, to its self-consciousness. His is no external deity related to the universe, as machinist to machine, but the immanent mind, whose organic life and growth, manifested to us in nature, is none other than evolution, which has dawned upon the investigators and thinkers of to-day.

On Polysynthesis and Incorporation as Characteristics of American Languages. By Daniel G. Brinton, M. D. Philadelphia. Pp. 41.

Dr. Brinton appears to have struck upon an undeveloped mine of linguistic research. Philologists have told us of monosyllabic, agglutinative, and inflectional languages, and of analytic and synthetic languages, and we have means in the libraries of books they have written upon them of learning all about them. The American languages, according to the present author, present entirely different types—those named in the title above—which have so far been only vaguely described, probably because they were only vaguely understood. Polysynthesis, according to Dr. Brinton, is a method of word-building which employs juxtaposition of words with the modifications they usually undergo when brought together, and also words, forms of words, and significant phonetic elements which have no existence apart from the compounds into which they enter. By incorporation, the nominal and pronomial elements of the proposition are subordinated to the verbal elements, and either have no independent existence in the form required by the verb, or are included within the specific verbal signs of tense and mood. By the use of these methods, of which various illustrative examples are given from several languages, the whole sentence is woven into a single word. These peculiarities constitute the American languages a distinct and independent class.

Consanguineous Marriages: their Effect upon Offspring. By Charles F. Withington, M. D. Roxbury, Massachusetts. Pp. 32.

Dr. Withington inquires into the validity of the belief that consanguinity of parents is in and of itself detrimental to offspring. He finds the evidence usually presented in favor of that opinion insufficient to demonstrate it. He presents evidence collected by himself, which, while he is far from regarding it as decisive, seems to go a great way toward justifying a negative view of the case.

Bad Times. An Essay on the Present Depression of Trade, tracing it to its Sources in Enormous Foreign Loans, Excessive War Expenditure, the Increase of Speculation and of Millionaires, and the Depopulation of the Rural Districts. With Suggested Remedies. By Alfred Russel Wallace, LL. D. New York: Macmillan & Co. Pp. 118. Price, 75 cents.

A premium was offered in England, known as the "Pears Prize," of one hundred guineas for the best essay on the depression of trade. Mr. Alfred Russel Wallace, the celebrated naturalist and philosophic thinker, who anticipated the chief work of Darwin, competed for it. It was, of course, thought singular that a traveling naturalist, a collector of butterflies, and an investigator on the origin of species, should have the assurance to strike into the great field of finance and international trade relations with a view of determining the causes of the present extensive hard times. But Mr. Wallace was not unprepared for the task. In his early life he had spent twelve years as a land surveyor and valuer, when he had much observation of agricultural life, and became familiar with a wide range of facts which had a bearing upon the land question now so prominent, and all of which gave a turn to his thought that well prepared him to take up the present discussion. But Mr. Wallace did not get the prize. His independent handling of the general subject, the deviation of many of his views from orthodox lines, and the introduction of new and more comprehensive causes of the prevailing bad times, probably explained the failure of his essay before the committee of award.

But the book is none the less valuable because uncrowned with a golden prize, and he did well to have it printed. In reviewing his previous works we have had repeated occasion to speak of his power as a clear thinker and lucid writer, and the present volume illustrates these traits as signally as anything he has previously done. He first states the general problem, and then considers the popular explanations for the extensive business depression, which is followed by the criteria indispensable to a true explanation. In successive chapters he takes up the baneful influence of extensive foreign loans, both upon England

and the numerous countries which have received her capital. Prominent among the causes of business calamity he discusses the recent increase of war expenditures, rural depopulation, pauperism in England and Ireland, bad agricultural policy, millionaires as a cause of depression, speculation and finance, adulteration and dishonesty. In Part II several brief chapters are devoted to the suggestion of remedies.

The view taken by Mr. Wallace is broad and very instructive. His facts are copious and pertinent, and the reasoning cogent and forcible. His ideas are far more elevated and philosophical than we are accustomed to in treating this class of questions. This well appears in his closing paragraphs. He says: "In conclusion, I wish to direct my readers' attention to a very suggestive fact elicited by our present inquiry, and which appears to me to express the moral teaching of the whole subject. In every case in which we have traced out the efficient causes of the present depression, we have found it to originate in customs, laws, or modes of action which are ethically unsound, if not positively immoral. Wars and excessive war armaments, loans to despots, or for war purposes, the accumulation of vast wealth by individuals, excessive speculation, adulteration of manufactured goods, and lastly, our bad land system, with its insecurity of tenure, excessive rents, confiscation of tenants' property, its common-inclosures, evictions, and depopulation of the rural districts—all come under this category; while the one apparent exception, the bad seasons, would have been comparatively harmless (as instances here quoted have shown) under a thoroughly good system of land-tenure.

"We thus see that the evils under which we have suffered, and are still suffering, are due to no recondite causes, to no laws of inevitable fluctuation of trade, but wholly to our own acts, and to those of other civilized nations. Whenever we depart from the great principles of truth and honesty, of equal freedom and justice to all men, whether in our relations with other states, or in our dealings with our fellow-men, the evil that we do surely comes back to us, and the suffering and poverty and crime of which we are the direct or indirect causes, help to impoverish ourselves. It is, then, by applying the teachings of a higher morality to our commerce and manufactures, to our laws and customs, and to our dealings with all other nationalities, that we shall find the only effective and permanent remedy for depression of trade."

Overpressure in Schools, pp. 11; Sanitary Science and Public Hygiene, pp. 9. By W. S. Robertson, M. D. Muscatine, Iowa.

The author of these papers is President of the Iowa State Board of Health, and in the essays discusses two very important points in public hygiene. The former paper relates to the effects of overpressure upon the health and progress of school-children, and the signs by which its evil workings may be discovered. The second paper relates to the importance of diffusing sound information among the people, in order that they may recognize the value of sanitary science, and may learn how to participate in its benefits.

American Constitutions. By Horace Davis. Baltimore: N. Murray. Pp. 70. Price, 50 cents.

This is one of the Johns Hopkins University studies in historical and political science. Its purpose is to follow the changes in the relations of the three departments of government—legislative, executive, and judicial—which have been silently going on in the United States for the past century. In the State governments, under numerous alterations in their Constitutions, the powers of the Executive have been steadily enlarged, and the functions of the Legislature have been cramped and limited; in the Federal Government, Congress has encroached upon the field of Executive power; and everywhere, in both national and State governments, the judiciary has gained vastly in power and importance. The author believes that there have been three distinct strata of government in the old thirteen colonies. In the first or colonial period, the Executive was too strong; in the second, the Legislature; in the third, the balance was restored, and our State Constitutions are to-day, he believes, "as a whole, the most perfect framework of government for men living in a democracy, that human skill has ever devised."

New York Agricultural Experiment Station. Third Annual Report of the Board of Control, for 1884. Albany: Weed, Parsons & Co. Pp. 424, with Plates.

The station is reported as now better equipped for its work than at any previous period. Not only have the apparatus for scientific and practical work been provided, but information has been and is being acquired regarding the condition of our soil and climate. The work at such a station is necessarily cumulative in its character, and each year must mark improvement in conditions whereby previous work may become more available. Considerable space in the report is devoted to the examination of "duplicates," under the conviction that where true duplicates can not be obtained, "it is unwise to expend our energy in attempting work over which we can have no check. . . . Indeed, until agricultural science, so called, can be subjected to the tests that are recognized as essential to correctness in other sciences, we can not hope for that progress which we desire." The most important feature of the present report is the description and classification of the varieties of corn, which are graphically illustrated in the plates. The attempt at classification has been extended to the varieties of vegetables, of which some twelve hundred have been grown, "but the work is a difficult one, and requires much careful study." Other subjects embraced in the report are the trial of germinations, the rooting habits of plants, nitrogen-supply, feeding-experiments, and experiments with milk.

Italian Popular Tales. By Thomas Frederick Crane, Professor of the Romance Languages in Cornell University. Boston and New York: Houghton, Mifflin, & Co. Pp. 389. Price, $2.50.

The growing interest in the popular tales of Europe, and in the new branch of anthropological research, folk-lore, is the justification for the appearance of this handsome volume. By popular tales, the translator means the stories that are handed down by word of mouth from one generation to another of illiterate people, serving almost exclusively to amuse but seldom to instruct. They may be roughly divided into three classes: nursery tales, fairy stories, and jests. They were regarded with contempt by the learned till the brothers Grimm some sixty years ago collected those of Germany and introduced them to the public. Now they are industriously sought for and collected from all parts of the world. The stories in the present volume are, for the most part, presented for the first time to the English reader, and have been translated from recent Italian collections, which give them exactly as they were taken down from the mouths of the people. The stories are annotated for comment and illustration, and the subject is further elucidated by a history, in the introduction, of the principal Italian collections, and a bibliography.

Two Years in the Jungle. By William T. Hornaday. New York: Charles Scribner's Sons. Pp. 512, with Map and Plates. Price, $4.

Mr. Hornaday is chief taxidermist in the United States National Museum, and was for several years collector for the natural science establishment of Professor Henry A. Ward, of Rochester, New York. The observations and adventures related in this book are such as happened to him while on a collecting tour for that gentleman, in the course of which he spent two years in India, Ceylon, the Malay Peninsula, and Borneo. That which he describes in it is offered as a faithful pen-picture "of what may be seen and done by almost any healthy young man in two years of ups and downs in the East Indies." The author says that he has labored in preparing his pages "to avoid all forms of exaggeration, and to represent everything with photographic accuracy as to facts and figures. It is easy to overestimate and color too highly, and I have fought hard to keep out of my story every elephant and monkey who had no right to a place in it. I consider it the highest duty of a traveler to avoid carelessness in the statement of facts. A narrative of a journey is not a novel, in which the writer may put down as seen anything that might have been seen."

Journal of the American Akadêmê. Alexander Wilder, Editor. Newark, New Jersey. Pp. 24.

The American Akadêmê is an association having for its purpose to promote the knowledge of philosophic truth, and to work for the elevation of the mind from the sphere of the sensuous life into that of virtue and justice, etc. Its members, it will be discerned, are to a large extent students of the Platonic philosophy. The most important paper in the present number is by J. B. Turner, and is on "Differentiation of Energy as the Basis of Philosophy and Religion." Mr. D. A. Wasson discusses the possibility of teaching virtue by verbal precept, with a decided inclination to the negative view.

A Political Crime. By A. M. Gibson. New York: William S. Gottsberger. Pp. 402.

This book is further entitled "The History of the Great Fraud," by which is meant the "counting in" of Hayes and Wheeler as President and Vice-President of the United States in 1876, when half of the American people believed that the candidates on the opposing ticket had been fairly elected. Its fundamental proposition, embodied in its opening sentence, is that Tilden and Hendricks were elected, and "were deprived of their choice by illegal methods, bolstered by frauds, perjuries, and forgeries." The author adds, "The surprising thing is that within less than a decade an almost complete revulsion in the opinions of the minority [the Republicans] should have taken place." Mr. Tilden's case is presented in full. The proceedings of the Returning Boards are narrated in detail, and conspiracy is freely charged against many of the men who figured prominently in the transactions relative to the election. As no election is now pending, the book can not be regarded as a campaign document; and the author is entitled to the presumption that his purpose in preparing it is to preserve what he regards as important facts and materials for history.

Something about Natural Gas: Its Advantages, Use, Supply, and Economies. By George H. Thurston. Pp. 32.

A pamphlet which applies more particularly to the natural gas of Tarentum, near Pittsburg, and which also sets forth the advantage of that place as a manufacturing center.

A Mortal Antipathy: First Opening of the New Portfolio. By Oliver Wendell Holmes. Boston: Houghton, Mifflin & Co. Pp. 307. Price, $1.50.

A new book by Dr. Holmes, redolent of his versatile genius and worthy of his fame. Happy are they who survive to enjoy this ripest product of the author's exquisite thought, for verily, this world has produced but one Dr. Holmes, and verily, verily, there will never be another, no matter how long it takes the solar system to run down! Great genius is never duplicated in the present economy of things, and the individuality of Dr. Holmes will forever stand alone in the history of creative literature. So let us all thank God for our good fortune in getting another of his charming and peerless books.

The contents of the new volume appeared as a serial in the "Atlantic Monthly" last year, under the title of "The New Portfolio." The scientific element which has been so striking and peculiar a characteristic of the former writings of Dr. Holmes here appears in the delineation of the career of a young man who, in infancy, had suffered a nervous disturbance so "sudden, overwhelming, unconquerable, appalling," from the carelessness of a pretty girl, that its effect remained in the system, so that afterward the sight of any young lady caused a repetition of the organic shock and deadly collapse. He was sent to a boys' school, and grew up to manhood the victim of this "mortal antipathy." The development of the story brings the young man, himself a physician of exquisite traits of mind and character, into such relations as, in the first place, to throw into a clear light all the physiological and medical aspects of the case, and then, with the most perfect art, the author relates the history of his restoration. The book is of absorbing interest, as well from its curious instructiveness as from the fascination of the story.

Milk Analysis and Infant Feeding. By Arthur W. Meigs, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 102. Price, $1.

Dr. Meigs publishes this little volume in the hope of contributing something toward the solution of the question of the composition of human milk, believing that, if some uniformity of opinion could be arrived at on the subject, it would be a great step in advance toward the attainment of some positive conclusion in regard to the artificial feeding of infants. After a long and careful study of the matter, he is convinced that human milk contains much less casein than is commonly attributed to it; and he here puts forth his reasons, and a detail of the methods by which his conclusions have been attained.

A Text-Book of Medical Chemistry. For Medical and Pharmaceutical Students and Practitioners. By Elias H. Bartley, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 376. Price, $2.50.

This book is designed especially as a text-book for medical students during their attendance upon lectures, and as a book of ready reference for physicians. The author, who finds the ordinary chemical text-books too voluminous and largely occupied with matter irrelevant to the wants of the medical student, has prepared in this one such a one as his experience of twelve years in the Long Island College Hospital, in which he is a professor, has taught him that his students need. In the first of the four parts into which the work is divided, are presented fundamental facts in chemical physics; in the second part, the elementary theories of chemistry; in the third part, the natural history of the elements and principal compounds, with their physiological and toxicological bearings; in the fourth part, those organic compounds only which the physician will be likely to meet. Tables and analyses are added for those who make the work a reference-book. The chemistry of the tissues and secretions is omitted, because it is considered to belong rather to physiological chemistry.

Saxe Holme Stories. First and Second Series. Pp. about 760. Paper. Price, 50 cents each series.

A Wheel of Fire. By Arlo Bates. Pp. 382. Price, $1. New York: Charles Scribner's Sons.

The "Saxe Holme Stories" attracted much interest when they were first published in "Scribner's Monthly," on account of their intrinsic merit, which was regarded as of the best, and of the mystery which was attached to their authorship. This was never revealed till a long time afterward. This interest has been renewed by the recent death of Mrs. "H. H." Jackson, and the avowal in connection with it that she was the author of the stories. They hold the first place among works of the class to which they belong. "A Wheel of Fire" is a tragic story of a young woman whose life was tormented by the apprehension of hereditary insanity, and all of whose plans and movements were controlled or modified by it.

Bird-Ways. By Olive Thorne Miller. Boston and New York: Houghton, Mifflin & Co. Pp. 227. Price, $1.25.

A collection of sketches of the ways of certain birds which the author met in the fields or had as pets in her house, and of their moods and methods of expressing them. With the exception of a few incidents which are properly credited, everything recorded in the volume came, she says, under her own observation, and is literally and entirely true so far as the fact is concerned, although she may have sometimes misconstrued the motives of the little actors in the drama.

The Heart, and how to take Care of it. By Edwin M. Hale, M. D. New York: A. L. Chatterton Publishing Company. Pp. 94.

The author has been moved to present a popular treatise on this subject by his conviction of the importance of the heart in the economy of the human organism, and by a belief that the public should know more about its functions, and the means of preventing or at least modifying the dangers to which it is exposed. His exposition is clear, practical, and unsensational.

PUBLICATIONS RECEIVED.

Report of the Committee on Disinfectants of the American Public Health Association. Baltimore. 1885. Pp. 137.

Fifth Annual Report of the State Mineralogist of California for the Year ending May 15, 1885. By Henry G. Hanks. Sacramento. 1885. Pp. 235.

Memorials of Henry Brace Norton. Pp. 110.

Revision of the Palæocrinoidea. By Charles Wachsmuth and Frank Springer. First Section. Philadelphia. 1885. Pp. 138, with Plates.

Hand-Book to the National Museum of the Smithsonian Institution, Washington. New York: Brentano Brothers. 1886. Pp. 110. Illustrated.

Photography of the Infra-red Region of the Solar Spectrum, 4 pages; and Methods of determining the Speeds of Photographic Exposures, etc., etc., 14 pages, illustrated. By William H. Pickering. From Proceedings of the American Academy of Arts and Sciences.

A Plan for Ocean-Signals, Lightships, and Life-saving Stations, adapted for Coast and Deep-sea Service. By F. A. Cloudman. Rondout, N. Y. Pp. 15. Illustrated.

Digest of Laws governing the Issue of Municipal Bonds. Compiled by C. G. Neely. Chicago, Ill.: Published by S. A. Kean & Co., Bankers. Pp. 91.

Telescope Search for the Trans-Neptunian Planet. By David P. Todd, M. A. Lawrence Observatory, Amherst, Mass. Pp. 16.

The Inertia of the Eye and Brain. By James M. Cattell. London: William Clowes & Sons, Printers. 1885. Pp. 20.

Marsill's Almanac of Meteorology, for 1886. Rock Island, Ill. 1885. Pp. 44.

Joint Diseases: Treatment by Rest and Fixation, 15 pages; and Surgical Treatment of Infants, 12 pages. By Dr. De Forest Willard, of the University of Pennsylvania.

Annual Report of the Secretary of the Treasury for the Year 1885. Washington: Government Printing-Office. 1885. Pp. 114.

Bulletins of the United States National Museum. No. 23. Bibliographies of American Naturalists. II. The Published Writings of Isaac Lea, LL. D. By Newton Pratt Scudder. Pp. 337. No. 28. A Manual of American Land-Shells. By W. G. Binney. Pp. 528. Illustrated. No. 29. Results of Ornithological Explorations in the Commander Islands and Kamchatka. By Leonhard Stejneger. Pp. 381, with Plates. Washington: Government Printing-Office. 1885.

On Heating and Ventilation of Dwellings and School-rooms. By Charles O. Curtmon, M. D. Missouri Medical College. Pp. 10.

Reception-Day. No. 4. Recitations, etc., for Private and Public Schools. New York: E. L. Kellogg & Co. 1885. Pp. 156. 25 cents.

The Wherewithal, or New Discoveries in Cause and Effect. Philadelphia: Townsend. Wherewithal Publishing Company. 1885.

Report of Professor Spencer F. Baird, Secretary of the Smithsonian Institution, for Six Months ending June 30, 1885. Washington: Government Printing-Office. 1885. Pp. 46.

Notes on the Opium Habit. By A. P. Meylert, M. D. New York: G. P. Putnam's Sons. 1885. Pp. 49.

The City of Washington: Its Origin and Administration. By John Addison Porter. Johns Hopkins University Studies. Baltimore. 1885. Pp. 66. 50 cents.

The Genesis of Inventions. By Franklin A. Seely, A. M. Washington. 1885. Pp. 17.

Ericsson's Destroyer and Submarine Gun. By William H. Jaques. New York: G. P. Putnam's Sons. 1885. Pp. 48. 50 cents.

The Utilization of Culm in Agriculture. By J. A. Price. Scranton, Pa. 1885. Pp. 5.

The System of High Licenses. How it can be made successful. By G. Thomann. New York: The United States Brewers' Association. 1885. Pp. 36.

National Conference of State Boards of Health. Pp. 63.

Report of a Special Committee of the Franklin Institute, of Pennsylvania, on Competitive Tests of Dynamo-Electric Machines, and on Mechanical and Electrical Tests of Conducting Wires. Philadelphia. 1885. Pp. 65.

Gas-Engines. Report of the Examiner of Section XII, International Electrical Exhibition. Franklin Institute. Philadelphia. 1885. Pp. 11.

The Healing Art. Harveian Oration delivered before the Royal College of Physicians, October 19, 1885. By Richard Quain, M. D., F. R. S. London: Longmans, Green & Co. 1885. Pp. 44.

A Study of the Relative Poisonous Effects of Coal- and Water-Gas. By William T. Sedgwick and William Ripley Nichols. Pp. 41.

Contributions to Mineralogy. By F. A. Genth. University of Pennsylvania. 1885. Pp. 17.

Precious Stones. By George F. Kerry. Washington: Government Printing-Office. 1885. Pp. 62.

Diseases of the Perspiratory and Sebaceous Glands. By George H. Rohé, M. D. Baltimore. 1885. Pp. 62. 25 cents.

A Farmer's View of the Protective Tariff. By Isaac W. Griscom. Woodbury, N. J. 1885. Pp. 53. 35 cents.

The Geological Formation of Long Island, with a Description of its Old Water-Courses. By John Bryson. New York. 1885. Pp. 17.

Mineral Waters. By A. C. Peale. Washington: Government Printing-Office. 1885. Pp. 10.

The Columbia Bicycle Calendar for 1886. Boston, Mass.: Pope Manufacturing Company.

Thermometer Exposure. By Henry A. Hazen. Washington Signal-Office. 1885. Pp. 32.

Bulletins of the United States Geological Survey. No. 7. A Catalogue of Geological Maps relative to North and South America. No. 8. On Secondary Enlargements of Mineral Fragments of Certain Rocks. No. 9. A Report of Work done in the Washington Laboratory during the Fiscal Year 1883-'84. No. 10. On the Cambrian Faunas of North America. No. 11. On the Quaternary and Recent Mollusca of the Great Basin, with Descriptions of New Forms. No. 12. A Crystallographic Study of the Thinolite of Lake Lahontan. No. 13. Boundaries of the United States and of the Several States and Territories. No. 14. On the Physical Characteristics of the Iron Carburets, etc. Washington: Government Printing-Office. 1884 and 1885.

Bad Times. By Alfred Russel Wallace. London and New York: Macmillan & Co. Pp. 118. 75 cents.

The Iron Crown. A Tale of the Great Republic. Chicago: T. S. Denison. 1885. Pp. 560. $1.50.

Wonderful Escapes. Revised from the French of F. Barnard; and Original Chapters added by Richard Whiteing. 1885. Pp. 308. Illustrated. $1. Valentino. By William Waldorf Astor. 1885. $2. The Sun. By Amadée Guillemin. From the French by A. L. Phipson. 1885. Pp. 292. Illustrated. $1. The Greek Islands and Turkey after the War. By Henry M. Field, D. D. 1885. Pp. 228. Illustrated. $1.50. Wonders of European Art. By Louis Viardot. 1885. Pp 335. Illustrated. $1. Strange Case of Dr. Jerkyll and Mr. Hyde. By Robert Louis Stevenson. 1886. Pp. 138. $1. Color Studies. By Thomas A. Janvier. 1885. Pp. 227. $1. New York: Published by Charles Scribner's Sons.

The Philosophy of Education. By T. Tate, F. R. A. S., with an Introduction by Edward E. Sheib, Ph. D. New York: E. L. Kellogg & Co. 1885. Pp. 331.

Social Wealth. By J. K. Ingalls. New York: The "Truth Seeker" Company. 1885. Pp. 320. $1.

A Hand-Book of Whist. By Major Tenace. 1885. Pp. 110. 75 cents. The Industrial Situation and the Question of Wages. By J. Schoenhof. 1885. Pp. 157. Brain-Rest. By J. Leonard Corning, M. D. 1885. Pp. 135. $1. New York: G. P. Putnam's Sons, Publishers.

Applied Geology. By Samuel G. Williams. 1886. Pp. 386. $1.40. Ecclesiastical Institutions. By Herbert Spencer. 1886. Pp. 182. $1.25. Anthropoid Apes. By Robert Hartmann. 1886. Pp. 326. $1.75. New York: D. Appleton & Co., Publishers.

Japanese Homes and their Surroundings. By Edward S. Morse. With Illustrations by the Author. Boston: Ticknor & Co. 1886. Pp. 372. $5.

Third Annual Report of the Bureau of Ethnology, 1881-'82. By J. W. Powell, Director. Washington: Government Printing-Office. 1884. Pp. 606.

The Annals of the Cakchiquels. The Original Text with a Translation, Notes, and Introduction. By Daniel G. Brinton, A. M., M. D. Philadelphia. 1885. Pp. 234.

POPULAR MISCELLANY.

Employés and Employers.—The Lehigh Valley Railroad Company has established a relief fund into which the employés put voluntary contributions, and for every dollar put in by a person in its employ the company puts in another dollar. Thus, if the 14,000 employés contribute a dollar each, the company will contribute $14,000. The management of the fund is in the hands of President Wilbur and Paymaster Wilhelm. In case a contributor is disabled by accident, he is allowed three fourths as much per day as his contribution in the fund every working-day during his disability, for a period of six months. In case the accident results in the death of the contributor within six months, or if he is instantly killed, $50 is appropriated from the fund for the funeral expenses. If he leaves a widow and children under sixteen years of age, an allowance of one half the amount of his contribution, for every working-day, is appropriated and paid the widow for one year from the time of the contributor's death, provided she remains unmarried during that time. If there be no widow, then the allowance goes to the children, if any, for the same period. In case the contributor loses a limb, he is provided with an artificial limb, and employment is given to him. —*Railway Review.*

Vapor- and Hot-Air Baths.—The value of hot-air and vapor baths, as well as of other means of promoting the perspiratory function of the skin, has been recognized from very ancient times; and nearly all peoples are acquainted with some means of producing the desired effect. The modes of taking these baths are exceedingly various. Among them are the Turkish and Russian baths, which are, however, usually arranged on too large a scale to be regarded as practicable for small households. Of hot-air baths, the extemporized "rum-sweat" is among the most common. The naked person is seated in a chair, enveloped in blankets which, spread over the chair, inclose him as in a kind of tent extending from his neck to the floor. The heat is supplied by burning spirit contained in a small earthen vessel, which is slipped underneath the chair. This method is attended with considerable peril, the reality of which has very recently been forcibly brought to mind by the death of Dr. W. B. Carpenter, who, taking a hot-air bath in almost precisely this way—using a gallipot of burning spirit instead of his bath-lamp, which was out of order—upset the vessel in changing position, and was so severely burned by the ignited vapors that he died in about four hours afterward. One of the simplest forms of vapor-bath was the old "hemlock-sweat," which, while it was a rude and far from convenient application, was efficacious, and had the character of a medicated bath. Hemlock-boughs, with the leaves, were broken up into a pail, and hot water was poured upon them, with the effect of immediately "steaming" the hemlock. The pail was then slipped under the blankets with which the bather was invested, while simultaneously a red-hot brick was dropped into it, whereby the bather was immediately involved in a profusion of aromatic steam, as hot as he could comfortably endure. We remember to have seen, many years ago, a simple, cheap, and tolerably convenient portable vapor-bath, in the shape of a chair constructed especially for the purpose, with provisions for burning alcohol with reasonable safety and producing steam, all contained within itself. The safest and most convenient arrangement which has come under our notice is the "Home Vapor-Bath," which was invented by Mr. William W. Rosenfeld, it is said, when he was only sixteen years of age. It is compact, and can be introduced, at small expense, into any house having "hot-water" attachments. It is applied to the ordinary bath-tub as it is found in nearly every good house, and, depending wholly upon the use of the hot-water pipe of the tub, avoids the direct application of fire. It can be used with any bath-tub, in addition to the other and usual arrangements, and without disturbing any of them. The principle of its operation consists in subdividing the hot water into small jets over a large area, so as to allow the maximum of evaporation. This is accomplished by affixing to one side of the tub a perforated shower-tube connected with the hot and cold water supplies. The bather sits upon a chair at the foot of the tub, enveloped in a curtain of rubber cloth, with an attachment extending over the tub. He is thus assured the full benefit of all the evaporation from the hot water, while his face is totally shut off from it, so that he does not breathe any of it. By means of another equally simple attachment, substances with which it may be desired to medicate the bath are brought into contact with the water and made to mingle their fumes with the steam. This form of bath, which has all the advantages of the Russian bath, and is, moreover, adapted to domestic use, has been introduced into a great many houses in New York and other places, as well as into hotels and public institutions, and is highly recommended by those who have employed it or examined it. In another form of apparatus, sold by J. Allen & Sons, of London, the lamp is placed outside of the curtain, within which the vapor is conducted by a pipe. The whole apparatus can be packed into a box less than twelve inches square. An arrangement is also furnished by which the vapors are introduced into the bed in which a patient may be lying; or the lamp, if preferred, may be put directly under the chair. This bath has received medals and high awards at several "health" or "sanitary" exhibitions.

A Sun-heating Apparatus for Rooms.—Professor Edward S. Morse, of Salem, Massachusetts, has tried the experiment of calling in the heat of the sun to assist in warming and ventilating his house. He attaches to the wall of his house a box nearly the height of the story, about three feet wide, and of suitable depth, and so arranged and connected with openings in the wall as to act as a flue. The outside of the box is made of slate or black corrugated iron, substances which absorb heat, and over this is a "window" of glass. With this apparatus, the air in a room measuring twenty-one by thirteen by nine feet, could be changed in forty-five or fifty minutes, and a very perceptible degree of warmth was obtained. A similar heater, forty-two feet long and six and a half feet wide, attached to the Boston Athenæum, is estimated to do work that would ordinarily require between twenty five and fifty pounds of coal a day.

Earthquake-proof Buildings.—The committee of the British Association appointed to investigate the earthquake phenomena of Japan, after reporting upon their experiments into the nature of the vibrations of the ground, offer some suggestions on the construction of earthquake-proof houses. In a house resting at its foundations on cast-iron balls, the measuring instrument showed that, although considerable movement took place at the time of an earthquake, all sudden motion had been destroyed; but wind and other causes produced movements of a far more serious character than the earthquake. To give greater steadiness to the house, eight-inch balls were tried, and then one-inch balls. Finally the house was rested, at each of its piers, upon a handful of cast-iron shot, each one fourth of an inch in diameter. By this means the building has been made astatic, and, in consequence of the greater increase in rolling-friction, sufficiently stable to resist all effects like those of wind. The shot rest between flat iron plates. When erecting a building in a region subject to earthquakes, it appears that we ought first to reduce, as far as possible, the quantity of motion which ordinary buildings receive; and, second, to construct a building so that it will resist that portion of the momentum which we are unable to keep out. To reduce the momentum we may—1. Select a site where experiment shows that the motion is relatively small. 2. For heavy buildings, adopt deep foundations (perhaps with lateral freedom), or, at least, let the building be founded on the hardest and most solid ground. 3. For light buildings, put in the shot foundations. As against the momentum which can not be cut off from the building, it should be borne in mind that it is chiefly stresses and strains which are applied horizontally to a building that have to be encountered. A vertical line of openings, as in doors and windows in a building, constitutes a vertical line of weakness to horizontally applied forces. Avoid coupling together two portions of a building which have two vibrational periods, or which, from their position, are not likely to synchronize in their motion. If such parts of a building must of necessity be joined, let them be so joined that the connecting link will force them to vibrate as a whole, and yet resist fracture. Brick chimneys in contact with the framing of a wooden roof are apt to be shorn off at the point where they pass through the roof. Light archways connecting heavy piers will be cracked at the crown. To obviate destruction from these causes, a system of building may be adopted which essentially consists of tying the building together at each floor with iron and steel tie-rods, crossing each other from back to front and from side to side. The center of inertia of a building, and of its parts, should be kept as low as possible. Heavy tops to chimneys, heavy copings, and balustrades on walls and towers, heavy roofs and the like, are all of serious danger to the portion of the structure by which they are supported. When the lower part of a building is moved, the upper part, by its inertia, tends to remain behind, and serious fractures often result.

Poteline.—The plastic substance, poteline, introduced by M. Potel, is formed of a mixture of gelatine, glycerine, and tannin, to which may be added sulphate of baryta or zinc-white; and the whole may be colored, if desired, with vegetable colors. Poteline is molded while still hot; and, when it has become cool, yields itself to every kind of manipulation. It can be turned, filed, bored, or screwed, and it is susceptible of a very fine polish, which may be conveyed by pressure. This facility of working permits it to be treated in the same way as bronze, and makes it adaptable for all kinds of mountings. It can also be used to seal bottles and jars hermetically, for the fabrication of dolls' heads that can not be broken, and for the composition of an artificial marble out of which ink-stands, door-knobs, and a thousand other articles can be made cheaply. The proportion of the different materials entering into the composition of this substance varies according to the use that is to be made of it. For sealing bottles, it should be used in a nearly liquid condition; for the manufacture of fancy articles, in an opaque form; while the exact composition of the marble-poteline is a secret known only to the inventor. M. Potel has described a method by which he uses poteline as an envelope, to stop and prevent fermentation and insure the preservation of fruits and meats.

Oyster-Culture in Connecticut.—According to the last report of the Shell-fish Commissioners of the State of Connecticut, the policy of farming out the oyster-grounds to individual proprietor-cultivators has been very successful. The number of persons engaged in the business increased ten per cent during the seven months covered by the report; and the rapid development of the oyster industry is further shown in the continued extension of the area of grounds devoted to it, and in the increase in the number of oyster-steamers. It has been found that with reasonable care and labor the number of star-fish may be so reduced that those enemies shall be incapable of doing serious damage to the oyster-beds. A new enemy, however, threatens the beds, in the shape of a sand-tube-building worm, whose structures cause accumulations that suffocate the oysters; but the estimates are contradictory as to the amount of the damage it is likely to do. Efforts have been made during the past year, with much success, to redeem muddy grounds and make them available for oyster-cultivation by covering them with shells and pebbles brought from the Housatonic River. The demand, both for oysters and for seed-oysters, is constantly increasing, and it is not likely that the supply will soon go ahead of it.

What is a Real Forest?—In all forest-culture, says Mr. M. C. Read, in a paper on "The Preservation of Forests on the Head-Waters of Streams," which is published by the Department of Agriculture in "Special Report No. 5," "it should be remembered that, for climatic purposes, an orchard of trees is not a forest. The planting of trees along the highways, about our homes, in parks and groves, ought to be encouraged for a variety of reasons, but will have little of the climatic effect of true forests. A dense growth of underbrush, herbaceous plants, and mosses under the larger trees, which will retain the fallen leaves in place, fill the surface-soil with rootlets, checking the flow of water and facilitating its entrance into the earth, is an essential part of a true forest."

Popularizing Agricultural Colleges.—In the Convention of Delegates from Agricultural Colleges and Experiment Stations, which was held at the Department of Agriculture in July, 1885, the question was considered how the colleges can be made more directly useful and more in sympathy with the people. President Fairchild, of the Kansas State Agricultural College, said that the Michigan College had arranged in 1875–'76 for a series of farmers' institutes to be held each winter in the different counties of the State. At each institute, the college undertook to provide only half of the programme, and insisted that the place where the meeting was held should provide the other half. The expenses of the institute were also divided equitably. Every question brought forward was open to discussion, to which close attention was given, and which was always encouraged. From that day to this, the institute has grown in favor, with both the farmers and the professors in the Agricultural College. "The same thing," Mr. Fairchild added, "has been in vogue with us in Kansas since I went there in 1879. We opened a series of institutes in the winter of 1880–'81, and have continued them from that day to this, with growing interest, and with especial favor as regards the farmer. We promote discussion upon just such questions as the farmers wish discussed, and the professors take especial pains to meet the questions which may be raised by the farmers themselves." The people are thus brought into full fellowship, which they demonstrate, with the college; and in Michigan the reports of the State Board of Agriculture, which formerly had to be "thrown at the heads of politicians," are in demand and are read.

More about the Effects of Tobacco.—Dr. Hobart Amory Hare, of the University of Pennsylvania, after an elaborate dissertation on "The Physiological and Pathological Properties of Tobacco," expresses the conclusions that "tobacco does no harm when used in moderation—to the man who, by occupation, leads an out door life, or one in which much physical exercise is taken, but rather does good, by quieting any tendency to continued action which may exist; to those who, by exceptionally long use, have become inured to the effects of the drug, and whose systems depend upon it; or to those whose temperaments are naturally phlegmatic and easy-going. Tobacco does harm to the young and not yet full-grown; to the man of sedentary habits; to the nervous and those whose temperaments are easily excited; and to the sickly and those who, by idiosyncrasy, are strongly affected by the drug." The different methods of using tobacco are harmful in the following order: Chewing, cigarette smoking, cigar smoking, pipe smoking, Turkish-pipe smoking. The quality of the drug governs the degree of its harmfulness more stringently in some cases than in others, as do also the character and constituents of the paper in which cigarettes are wrapped. Finally, the oft-repeated words "excess" and "moderation" "form the key-stones of the arches which the writers on tobacco, *pro* and *con*, have raised."

Life in New Guinea.—The Rev. J. Chalmers, a missionary, recently visited the country west of Maclatchie Point, Southeastern New Guinea. He found the people generous and hospitable. They are certainly cannibals, but only as concerns their enemies. Sorcery and superstition have their home among them. In a *dubu*, or sacred house, which Mr. Chalmers describes as the finest he has ever seen, two large posts, eighty feet high, support a large peaked portico, thirty feet wide, while the whole building is one hundred and sixty feet long, and tapers down in height from the front. A large number of skulls of men, crocodiles, cassowaries, and pigs ornament it. The human skulls are those of victims who have been killed and eaten by the tribe; and they speak of this kind of food as the greatest luxury, and think those are fools who despise it. The whole district from Orokolo to Panaroa is one great swamp, and the villages are all surrounded by muddy water. Canoes are a necessity in making morning calls. Bridges of logs or trunks form the streets, and the roads are more easily traversed barefoot than in boots. The houses are really well built, and in front of many of them are small gardens, raised ten feet from the ground. To make these gardens, a well-built platform is covered with soil, in which flowers and tobacco are planted and cultivated.

The International Geological Congress.—The International Geological Congress held its sessions in Berlin from the 28th of September to the 4th of October last, and was attended by two hundred delegates of various nationalities, among whom were Mr. McGee, Professor Newberry, and Professor James Hall, from the United States. The German geologist, Von Dechen, who is eighty-five years old, was named honorary president, while Professor Beyrich served as effective president. Among the important matters to receive attention was the report of progress upon the geological map of Europe, the execution of which had been put in charge of a special commission by the preceding Congress at Bologna. The choice of colors made at Bologna was pronounced a happy one; and the principle of marking the subdivisions of periods by graduated tints of the same color, the darker tints indicating the older beds, was approved. The report on nomenclature stated that, while the Congress of Bologna had established the fundamental principles on the subject, there were some important matters which it had not settled, and upon which the international committees had not been able to agree. On the points considered in this report the Congress decided that the Triassic and Jurassic formations should be divided into three series each, and the Cretaceous into two, the lower series including the Gault. On other points, on which differences of opinion were more pronounced, discussion was remanded to special publications and to future consideration. Professor Neumayr, of Vienna, asked the sanction of the Congress to his contemplated "Nomenclator Palæontologicus," to be published in fifteen volumes of a hundred pages each, in which should be given the names of all vegetable and animal fossils, with the beds in which they occur and the works in which they are described. It will have a French introduction and a Latin text, as brief as possible. The next meeting of the Congress was appointed to be held in London in 1888, between the 15th of August and the 15th of September.

The New England Meteorological Society.—At the annual meeting of the New England Meteorological Society, held in Boston, October 20th, Professor Davis read a paper upon the thunder-storms of the summer of 1885, and Mr. Harold Whiting a paper on the self-recording aneroid barometer. A full presentation of the year's work of the society was given in the report of the Council. The number of members had increased from nine in November, 1883, to ninety-five; the number of observers sending reports from forty-five to one hundred and twenty-three. Efforts had been constantly made to secure increased accuracy and greater uniformity in the observations. The subject of accurate instruments received early attention; and it was decided to manufacture a special class of rain-gauges rather than to adopt any now in the market, and to adopt certain makes of self-registering thermometers. All desiring to make observations have been encouraged to do so, and efforts have also been made to secure observers in special localities. In co-operation with the United States Signal-Service, local weather-flags are daily displayed in more than a hundred cities and towns of New England. More than four hundred observers have co-operated in the special investigation of thunder-storms; and two hundred and three reports were sent in of a single storm. The National Academy aids these investigations with an appropriation of two hundred dollars. The expenses of the society have, by the aid of friends, been kept within its income. As its financial prosperity depends on the number of members, it is desired to include in the membership all who are interested in meteorological studies in New England, whether they make observations or not.

How to exalt the Teacher's Art.—"Teaching as a Business"—that is, why is it not a profession?—is the title of a paper which was read by C. W. Bardeen before the National Educational Association at its last meeting. One reason why teaching is not a profession lies in the way school boards are made up; another, in the fact that so large a proportion of incompetents are applying for positions, not forgetting the highest ones. It is not strange that, with such persons obtruding themselves, the teacher is looked upon by such boards as we have as "an impracticable man, useful enough to take care of boys and girls under rules established by lawyers, doctors, and business-men, but unfitted for participation in any of the serious work of the community." Mr. Bardeen, in looking for a remedy for the low state of the business, holds that it should not be thought to depend upon higher salaries or pensions for retired teachers, or fixed tenure of office—the teacher, if matters were in a proper condition, should be no more anxious about his annual re-appointment than the bank-teller or insurance president, who is sure of it so long as he is this side of the St. Lawrence! But teachers should discriminate among themselves in favor of the most competent, should be men among men, should see to it that the differences in the results of good teaching and poor teaching are proved, and emphasized, and illustrated, and should labor to have the work of superior teachers recognized and secured. The average school board is a checker-board, where the only important consideration is that the square be covered, with a button, if the real piece is not at hand; it should be like a chess-board, where, "when a knight falls to the carpet, you do not replace him by a pawn, a rook, or a bishop; and you will make almost any sacrifice to retain your queen. One of these pawns may sometimes be a queen, but not till by long probation and many steps of progress it has won its position in the queen's row. There should be a queen's row in teaching."

The Value of the Congo.—A letter from Mr. Stanley, protesting against giving up the control of the Congo to the Portuguese, which was read in the Geographical Section of the British Association, gives a magnificent idea of the value of what that river is capable of contributing to the advance of civilization. "Despite every prognostication to the contrary," says Mr. Stanley, "this river will yet redeem the lost continent. By itself it forms a sufficient prospect; but, when you consider its magnificent tributaries which flow on each side, giving access to civilization to what seemed hopelessly impenetrable a few years ago, the reality of the general utility and benefit to these dark tribes fills the sense with admiration. Every step I take increases my enthusiasm for my work and confirms my first impressions. Give 1,000 miles to the main channel, 300 to the Kwango, 120 to Lake Matenba, 300 to the Mobimbu, probably 800 to the Kaissai, 300 to the Saukuru, 500 to the Aruwimi, and 1,000 more to undiscovered degrees, for there is abundant space to concede so much, and you have 4,520 miles of navigable water."

A New Zealand Ice-Cave.—The Whaugachu River, of New Zealand, rises in an immense, deep, perpendicular walled ravine on the slopes of Mount Ruapehu, in which its descent is varied by a succession of waterfalls—"Horseshoe," "Bridal-Veil," etc., varying from 150 to 400 feet in height. "At one point, where the scene is hemmed in with towering precipices of 1,000 feet high and a glacier-slope in front, the gorge," says Mr. Nicholls, "wound in such a way that none of the surrounding country could be seen, and there was nothing but the blue heavens above to relieve the frigid glare of the ice, the cold glitter of the snow, and the dreary tints of the frowning, fire-scorched rocks. Right under the snowy glacier above us were wide-yawning apertures, arched at the top, and framed as it were with ice in the form of rude portals, through which the waters of the river burst in a continuous stream. We entered the largest of these singular structures, and found ourselves in a cave of some 200 feet in circumference, whose sides of black volcanic rock were sheeted with ice and festooned with icicles. At the farther end was a wide cavernous opening, so dark that the waters of the river, as they burst out of it in a foaming, eddying stream down the center of the cave, looked doubly white in comparison with the black void out of which they came. The roof of the cave was formed of a mass of frozen snow, fashioned into oval-shaped depressions, all of one uniform size, and so beautifully and mathematically precise in outline as to resemble the quaint designs of a Moorish temple; while, from the central points to which the edges of these singular designs converged, a long single icicle hung down, several inches in diameter at its base, perfectly round, smooth, and as clear as crystal, tapering off toward its end with a point as sharp as a needle." Wherever the water poured over the rocks it left a white deposit, which, when tasted, produced a marked astringent feeling upon the tongue, with a strong impression of alum, sulphur, and iron.

Malaria-Factories in Mauritius.—Reference having been made in a recent health-lecture at the Society of Arts to an outbreak—the first in the history of the island—of malarial fever which occurred in Mauritius in 1866, Mr. F. Guthrie, who was there at the time, gives a statement of what he found, upon examination, was the cause of the outbreak. The embankments of the new railroad had caused the accumulation of water in ponds on either side of the track. This became stagnant and impregnated with the sewage that surged down from the higher land, till it was strongly offensive to the sight and the smell. In view of the existence of these cess-pools on a grand scale, Mr. Guthrie does not believe that the outbreak was due to the "clearing of the forests" or to the "upturning of the virgin soil," but simply "to the infatuation of those who did not know, and who, even when it was pointed out to them, could not see that, when lagoons of sewage and salt-water are reeking beneath a semi-tropical sun, fever is the rule rather than the exception."

Dancing as Physical Training.—Dr. Crichton Browne has had a good word to say for dancing. In a recent lecture before the Birmingham (England) Teachers' Association, he insisted on the importance of a timely training and discipline of all motor centers, so that advantage may be taken of the superior plasticity that characterizes them during their period of growth. He spoke of the value of the educational training in this way of the hand-centers of to-be artisans, of the different kinds of muscle-work, and in regard to dancing said that, if taught at the proper time—that is, very early in life—it "may discipline large groups of centers into harmonious action, enlarge the dominion of the will, abolish unseemly muscular tricks and antics, develop the sense of equilibrium, and impart grace and self-confidence. Every day," he continued, "we may detect in the conversation or carriage of persons we meet painful evidences of the neglect of dancing and deportment in the rearing of the young."

Mechanical Repetition and Intellectual Knowledge.—It has sometimes been observed that, when children of savages are put to school, they exhibit great readiness, and sometimes precocity, in learning the elementary branches till they reach a certain age, when they all at once fall off. Professor W. Mattieu Williams regards this as a sign of their intellectual inferiority, and a consequence of it. The earlier instruction of these children "mainly consists in 'learning lessons,' mechanical practice in writing, and mechanical use of the rote-learned addition and multiplication tables. So far, mere verbal memory, finger-moving, and repetition-gabble of numbers, does all the work. The higher intelligence of the child contributes little or no aid in the performance of such tasks; it rather stands in the way by inducing thought, i.e., distracting the child's attention from the mechanical drudgery demanded. When work demanding thought is required, whether it be higher school-work or the business of practical life, the difference between the Caucasian and the lower races comes out; not because there is an arrest of development in the lower, but because the higher demand displays the working of the higher faculties. A glib aptitude for learning foreign languages is, generally speaking, an indication of intellectual inferiority, a simple result of the lower intellectual faculties being concentrated upon such mechanical effort without the distracting influence of the higher reasoning powers."

M. de Mortillet on Tertiary Man.—M. G. de Mortillet read a paper before the Anthropological Section of the French Association on Tertiary "man," in which he said the question was not one of knowing whether man existed in the Tertiary epoch as he exists to-day. Animals have varied from one geological stratum to another, and the higher the animals, the greater has been the variation. It is to be inferred, therefore, that man has varied more than the other mammals. The problem is to discover in the Tertiary period an ancestral form of man, a predecessor of the man of historical times. There are in the Tertiary strata objects which imply the existence in that age of an intelligent being; and such objects have been found in two different stages of the epoch—in the Lower Tertiary at Thenay, and in the Upper Tertiary at Otta, in Portugal, and at Puy Courny, in Cantal. They prove that at those two distant epochs there existed in Europe animals acquainted with fire, and able, more or less, to cut stone. During the Tertiary period, then, there lived animals less intelligent than existing man, but more intelligent than existing apes, although their skeletons have not yet been discovered, only their works. To these species, the ancestral forms of historic man, M. de Mortillet would give the name of anthropopithecus, or man-ape.

Words and Things.—A writer in the "Journal of Science" remarks upon the inadequacy of language to describe motions, as in the flight of different species of butterflies; colors, except a few particularly named ones; forms, except geometrical ones; and tastes and odors, in which the failure is complete. At the same time our mental conceptions of all these things may be of the clearest, when they have once passed under observation. To this he appends the pertinent question: Seeing how very impotent is language, unaided, to convey precise knowledge, "Why is such exclusive attention paid to words, both in lower and higher education, to the almost entire neglect of things? Verbal memory is cultivated above all other faculties of the human mind. Much care is taken to train up youth in the correct use of language. But in what school is the art of observation systematically taught? Who heeds or asks whether the observing faculties are strengthened? Quite the contrary; these faculties, if perhaps not intentionally, are not the less weakened and crowded out by dominant verbalism. . . . I am not seeking to undervalue the use and study of language. It furnishes, at any rate, receptacles in which the rough outlines of our knowledge may be preserved. But it must no longer seek to maintain the exclusive position which it has usurped. It must be made to feel that it is the espalier and not the vine, the purse and not the money, the shell and not the substance."

Sands of the Turkistan Deserts.—According to an account by M. Paul Lessar, of the Russian Geographical Society, the sands of the Kara-Kum Desert of Turkistan, represented on maps by one conventional sign, are in reality very varied, and are divisible into three principal kinds. In the country between Merv and Attok, and between Sarakhs and Chacha, the soil is clayey, largely mixed with sand; its surface is formed into hillocks, rarely more than seven feet high, and usually thickly overgrown with brushwood. This kind of desert presents no particular obstacles to the traveler. The second kind of desert consists of real sands—not, however, of a drifting nature, but everywhere knit together by bushes ten or fifteen feet high. It is only at the summits of the hillocks, which are higher than those just described, that there is a little drift-sand, which is carried from place to place. In sands of this kind, carts move with great difficulty, while horses and camels go freely. No storm need be dreaded in these deserts, for the quantity of drift-sands is so small that it can not become dangerous, though it may cause considerable discomfort. The case is, however, very different with the sands of the third kind, or the so-called *barkhans.* In them no tree or bush or grass-blade is to be seen; the sand is wholly of a drifting nature; and the slightest puff of wind effaces the fresh tracks of a caravan. Wherever they meet a bush they are deposited around it by the wind in hillocks that assume a variety of shapes. When the hillocks have covered the bushes they are molded by the wind according to one pattern, in which the side exposed to the wind presents a gradually raised cone, and the reverse a sharp curve, while a section might be accurately figured by a rib. The passage of these sands is very difficult. Horses sink and are hardly able to extricate their feet. It is necessary to proceed with the utmost caution in order not to lose one's way; for there is nothing to serve as a sign-post, except occasional sticks placed by passing caravans; and the wind blows them down and the sand covers them. Each successive caravan replaces them in the most convenient spot. These sticks have to be followed on the march, for, when the least wind is blowing, only the most skillful and experienced guides can trace the direction of the road. The *barkhans* shift from place to place; and plain evidence of their drifting nature appears before the eyes of every traveler between Merv and Bokhara. When they move, it is usually without undergoing any change of shape. Besides the sands in the Kara-Kum, M. Lessar describes the *kyrs*, *takirs*, and *shors*. The *kyrs* are firm surfaces of clay mixed with sand, only occasionally covered with sand-hillocks, and hardened by vegetation. They usually consist of a row of valleys alternating with eminences not exceeding from one hundred and forty to two hundred and ten feet in height, and are always passable. The *takir* is a very hard surface devoid of vegetation, surrounded on all sides by sands almost horizontal or sloping but slightly. The clayey soil is impervious to water, but presents a very slippery surface in rainy weather. *Shors* are similar in appearance to *takirs*, but distinguished from them by their soil, which is a ferruginous sand, with gypsum protruding in many places on the surface. They are sometimes dry and sometimes boggy; but in any case not difficult of passage.

Ancient Anæsthetics.—A recently discovered manuscript by Abélard gives some curious information concerning the means employed by the surgeons of his time to produce insensibility during their operations. Pliny mentions a stone of Memphis which, brayed and applied with vinegar, was put on particular parts of the body to anæsthetize them. He, Dioscorides, and Mattheolus speak of putting patients to sleep previous to operations by causing them to take, in bread or some other food, the juice of the leaves or a decoction of the roots of mandragora, or a dose of the plant called morion. Opium and hemp were used by the Chinese. In the poly-composite pharmacy of the thirteenth century a preparation was made of opium, the juices of henbane, mandragora, hemlock, and other plants, with which sponges were charged. Having been dried in the sun, the sponges were moistened when it was desired to use them, and then applied under the noses of the patients as chloroform sponges are now applied.

A Chinese Dinner in High Life.—A member of a Bremen trading-house lately had the honor of taking dinner with a Chinese magnate in Pekin, and has given an appetizing description of the feast. The table was set with twenty-two dishes, and was lit with ten large lanterns, the light of which shone clear through brightly colored shades and ornaments. Instead of being served in courses, the dishes were brought in one at a time and passed to the guests severally, beginning with the most distinguished or with the oldest. The merchant has given a list of them, with his comments, as follows: 1. Doves with mushrooms and split bamboo-sprouts—delicious. 2. Fat-pork fritters (or something like fritters)—splendid. 3. Pigeon's-eggs in meat-broth, the whites hard but transparent—very good. 4. Chinese bird's-nests with ham-chips and bamboo-sprouts (a mucilaginous dish)—excellent. 5. Poultry, different kinds, cooked with mushrooms and bamboo-sprouts—very agreeable. 6. Duck, with bamboo and lotus fruits, the fruits tasting and looking like an acorn without its cup—tolerably good. 7. Hog's liver fried in castor-oil—bad. 8. A Japanese dish of mussels with malodorous codfish and bacon—horrible. 9. Sea-crabs' tails cooked in castor-oil, with bits of bamboo and ham—would have been palatable but for the wretched oil. 10. A star made of pieces of fowl, bacon, and dove, covered with white of egg—very juicy. 11. Slices of sea-fish and shark's fins, with bamboo and mushrooms—it was hard to tell what kind of a dish it was, but it was rather bad than good. 12. Giblets of poultry with morels—the morels helped the giblets down. 13. Ham and cabbage—not particularly good. 14. Hams of sucking pigs cooked in their own juice. A pause now ensued, during which pipes and tobacco were brought in. The pipes held about a thimbleful of tobacco—enough for two or three whiffs—and we were kept busy filling and lighting them. 15. Land-turtles with their eggs in castor-oil—abominable. 16. Ends of ham—good. 17. Breast of fowl with sour cabbage—no delicacy. 18. Stale eggs (these eggs had been kept one month in salt and two months in moist earth). The whites looked like burned sugar, and were transparent. The yolks had a greenish color, and the embryos appeared dark, rolled together, and perfectly recognizable—a terrible dish. Dessert: Conserve of sitzon, a red fruit that looks like a shadberry, and tastes like a kind of currant—good. Dark-green fruits, having oval seeds like those of the plum, preserved in brandy—good. Crabs' tails cooked in castor-oil. A green, oval fruit with a long, hard seed, resembling a large green olive, but sharp and sour, and disagreeable to the European taste. Light cakes—very fine. Nuts, almonds, and castor-oil seeds, roasted and candied with sugar—good, even to the castor-oil seeds. Macaroni with sesame-seeds and three-cornered cakes covered with castor-oil seeds—passable. Various bonbons very moderate; baked lichis. The lichi is the finest of Chinese fruits, having a white flesh with the taste of the best grapes—excellent. Shaddocks and mandarin oranges—good. The only drinks were tea, very weak and without sugar, and samion, a rice-wine, which is drunk hot like tea, and is wretched stuff.

Temperature of Germination.—M. Hellriegel has undertaken, in a series of experiments on eighteen species of cultivated plants, to ascertain the lowest temperature at which seeds are capable of germinating. The seeds, sprinkled with distilled water, were planted in large receptacles filled with vegetable mold that were raised to constant temperatures of 48°, 40°, 38°, 35°, and 32°, and kept there from thirty-five to sixty hours. It was found that rye and winter wheat germinated at 32°. Barley and oats showed their cotyledons at 32°, but did not start till 35° were reached. Indian corn required 48°. The turnip germinated at 32°, flax at 35°, the pea and clover at 35°, the bean and lupin at 38°, asparagus at 35°, the carrot at 38°, and the beet at 40°. The respiratory function requires little heat, and operates even in the entire absence of light. Heat and light are, however, most favorable for the assimilation of carbonic acid and its conversion into carbon. But little importance is attached to the color of the light.

Dust in Rooms.—Professor W. Mattieu Williams contends that minute particles of dust are repelled or driven away from heated bodies, and that the repulsion operates in the open air and confined spaces alike. Large bodies, he adds, are similarly repelled, but as the repulsion acts only superficially and the inertia of a mass of given matter increases with the cube of its through dimension, and its surface only with the square of the same, the repulsion of such masses demands special and delicate arrangements to render it visible. Assuming this view—that dust is repelled from warmer to cooler bodies, be those bodies solid or gaseous—to be proved, then, "if the walls, floor, ceiling, and furniture of a room be warmer than the air of the room, the dust will be repelled from the walls, etc., to the air; while if the air be warmer than the walls the dust will be projected from the air to the walls." Hence those methods of warming rooms are to be preferred which heat the air rather than the solid objects; and this, in Mr. Williams's opinion, should exclude open fires.

NOTES.

The committee of the American Association on Indexing Chemical Literature, at the last meeting of the Association reported progress, by Professor William R. Nichols, on carbon monoxides; Professor L. P. Kennicutt, on meteorites; and Professor C. E. Monroe, on explosives. Dr. H. C. Bolton has published a catalogue of chemical periodicals, and Hans Wilder, independently of the Association, a list of nearly nine hundred chemical tests known by the names of their authors. Dr. Bolton's second index of the literature of uranium has been accepted. Dr. F. E. Engelhardt has offered to undertake an index to the literature of common salt. The committee's report presents a scheme for indexing scientific literature, in both author and subject indexes, prepared by Professor William Frear.

M. Demarçay, by means of an induction-coil made of comparatively large and short wire, obtains a spark, without having to employ strong currents, which is of sufficiently high temperature to give the spectra of all the known elements. Atmospheric lines of the second order are not obtained with it, and the nebulous bands of nitrogen and the lines of the electrodes only rarely.

Dr. Daniel G. Brinton, of Philadelphia, has been announced a laureate of the Société Américaine de France, and awarded the medal of the society, for his works on the "Aboriginal Tongues of America."

Professor Enrico Caporali, in a paper on the "Pythagoric Formula in Cosmical Evolution," published in the Italian quarterly, "La Nuova Scienza," holds, in general, in opposition to Herbert Spencer's theory of mechanical causes, that all evolution is due more to internal energy than to outward conditions.

The invention of binocular opera-glasses is generally attributed to the Bohemian Capuchin, P. Schyd. M. G. Govi, an Italian investigator, has, however, found that the first glasses of the kind were presented to King Louis XIII, by an optician of Paris named Chorez, in 1620.

Lundstrom has made investigations of the adaptations with which plants are provided for making the most of the water that comes to them in the shape of rain or dew. He has classified them as follows: Depressions in the shape of leaf-cups or of grooves in the epidermis; hair-formations, in tufts or borders; hydroscopic membranes in the shape of larger or smaller spots or stripes on the epidermis; and anatomical adaptations, such as water-absorbing textures and swelling glands. It is a noteworthy fact that all of these adaptations are wanting in the submerged parts of plants.

M. C. André, who is connected with a light-house at Pondicherry, India, tells of a fog-cloud about six feet broad which appeared at the top of the room-wall he was facing, while simultaneously a quick, sharp, and loud report was heard under his table. It sounded as if the whole underside of the table-top had been struck a hard blow, yet the table did not appear to have been moved, nor anything upon it. After the report, his plate took to spinning around on the table without any noise, showing that, though it had been thrown up from the table, it had not ceased to be touching it. This account is a part of the proceedings of the French Academy of Sciences of November 5th, and is designated a "meteorological phenomenon."

M. Philippe Thomas has discovered some very extensive deposits of phosphate of lime in the Tertiary strata of Southwestern Tunis.

M. Ludovic Breton has propounded a new theory of the formation of coal. He believes it is produced by the sinking of floating islands like those which now occur on many lakes and rivers, and which are conspicuous on the Upper Nile. These islands are composed chiefly of turf, which, being swallowed up by the water, becomes fossilized at the bottom.

M. Trève has described to the French Academy of Sciences a phenomenon of a beautiful green ray which he has observed to follow the disappearance, for a quarter of a second after sunset, of the upper limb of the sun's disk. The flash of the ray is as quick as that of lightning, and can be seen only under unusual conditions of clearness of the sky. The author explains the appearance under M. Chevreul's theory of the simultaneous contrast of colors.

M. de Loriol announced to the French Association the completion of his work in the "Paleontologie Française," on the fossil crinoids of France. He has described and figured 209 species, 89 of which are new to science. In the same work M. Cotteau has described 525 species, belonging to 50 genera, of *Echidnæ*. Nearly all of these species are characteristic of the beds in which they are found.

M. Wroblewski has observed that atmospheric air in liquefying does not follow the laws of liquefaction of a simple gas, but behaves like a mixture the elements of which are subject to different laws. If air so behaves that it has been possible, on superficial observation, to speak of its own critical point, it is because the difference in the curves of tension of the vapors of oxygen and nitrogen is so slight as easily to escape notice. Air may be made to give two distinct liquids, of different appearance and composition, one above the other, and separated by a distinct meniscus; the lower liquid containing by volume about 21½ per cent of oxygen, and the upper one, 17 or 18 per cent.

A Merovingian sepulchre has been discovered near Monteeaux, France, which seems to be so far unique in its way, and is supposed to date from the fourth or fifth century. It contained a mummified Frankish warrior, with his arms and clothes. The sarcophagus was made of a soft, calcareous stone, and had lids of the same material. The mummy was wrapped in a linen shirt and a woolen robe, with a belt-buckle in perfect preservation, and an iron sword. The shoes were also in good condition, and fastened with narrow straps of leather. At the feet was a funereal vase. The discoverer had replaced the sarcophagus and covered it up, so as to have it in safe keeping for future observation; but thieves came in the night to steal it away, and, hardly had they touched the skeleton, when bones, dress, and arms all fell into dust.

M. Gaston Tissandier's "La Nature," of Paris, has just entered upon its fourteenth volume, and, in recording the fact, announces that its career has been one of growing success. It began with a circulation of 2,000 copies, and now prints 15,000. It is a beautifully printed and profusely illustrated journal, whose aim is to direct the studies of French youth, "now eminently industrious and thirsting for knowledge because it has profited by the lessons of a recent past," into the channels which will be most beneficial. Besides recording clearly and concisely what occurs in every other field of science, it gives especial attention to the exposition of new applications of electricity, and of new conceptions and experiments in aërial navigation.

Colonel B. R. Branfill, late of the Survey of India, remarks as a noticeable feature in the meteorology of the southeast coast of that country the frequent lightning-storms, which occur daily, for weeks together, before the setting in of the southwest monsoon, unaccompanied by rain or by any sound of thunder. They are seen along the coast where the land and sea breezes alternate, and along the line of the Ghâts, where the surface-current is thrown up into the upper and opposite current of the atmosphere. In this region the rare phenomenon of interference fringes is very frequently to be seen.

The purpose of ventilating cellars is to make them cool and dry. They are often ventilated so as to be warm and damp. This is done when the air admitted to them from without is considerably warmer than the air within them. Coming into the cooler cellar, this air, while it raises the temperature of the cellar-air, itself is cooled, and deposits its moisture, which soon becomes evident as visible or palpable dampness. Therefore, all the ventilation of cellars in warm weather should be done at night; and the cellar should be kept closed between sunrise and sunset.

M. Trouvelot, in a paper about the late "new star" in the nebula in Andromeda, discusses the question whether the star has any physical connection with the nebula. He believes that it has not, because, in proportion as the star diminished again in brightness, the nebula acquired its pristine form. Thus the impression was given that the change noticed in the appearance of the nebula during the conspicuous visibility of the new star was only apparent, and was due to the superior light of the star having overpowered for a time the surrounding portions of the nebula.

M. Ch. Tellier, in a recent experiment, raised twenty-five hundred quarts of water in an hour from a depth of twenty feet, with a power generated simply by the natural heat of the sun.

According to accounts in "Land and Water," the gradual extinction of the buffalo is being followed up by an alarming increase in the depredations of wolves upon the sheep and cattle ranches. Both the gray wolf and the coyote are fast becoming more numerous. The sheep have suffered for some time from their ravages, and now the cattle are attacked. One pack of gray wolves, within fifty miles of Fort McLeod, has been known to attack and pull down steers two years old. The coyotes follow the fiercer animals, and are satisfied with what they leave, or with the smaller calves.

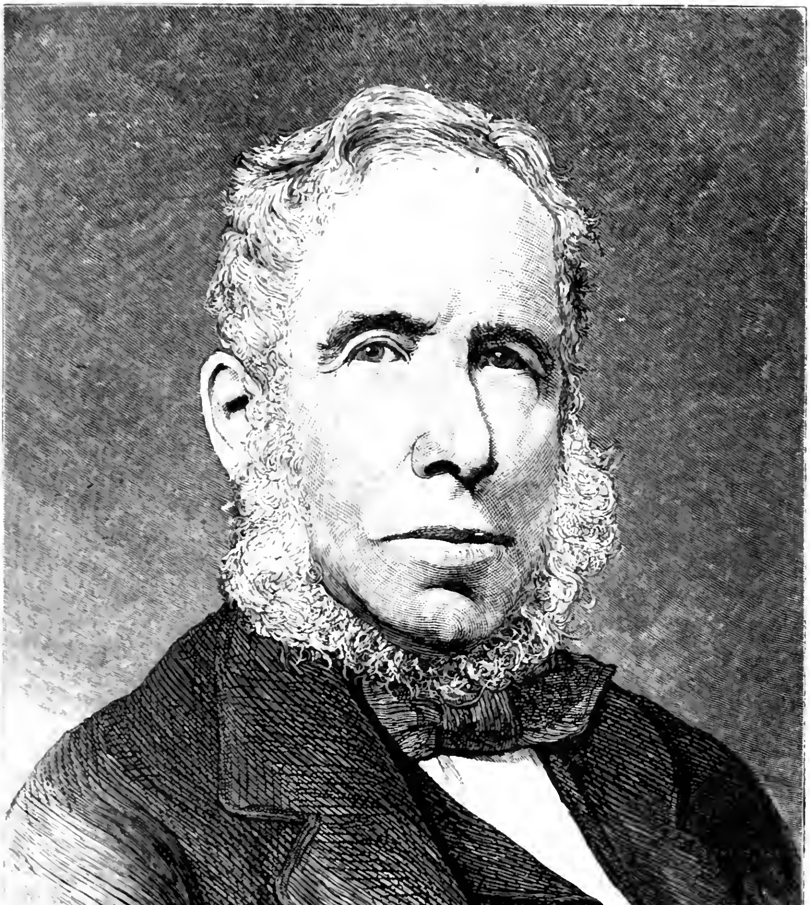
OBITUARY NOTES.

M. Bouley, President of the French Academy of Sciences, died November 30th, of a disease from which he had suffered long and painfully. His special field of research was in veterinary science, from which he drew many lessons beneficial in their application to human pathology. He appreciated the value of M. Pasteur's labors from a very early stage, and gave them his earnest co-operation; and his own researches in hydrophobia, epizoöties, and their remedies and preventives, entitle him to a distinguished place in the annals of contemporary biology. He was the author of books on experimental disease and on contagion, and his lectures at the museum have been highly spoken of.

The death is reported of M. Rabuteau, author of valuable researches in experimental therapeutics and chemical physiology. He was particularly interested in the investigation of supposed relations between the chemical composition and the physiological action of various bodies. He was for twenty years one of the most active members of the French Biological Society.

Captain Mangin, the inventor of the system of optical telegraphy which has recently been introduced for use in the French army, has recently died of apoplexy, at the age of forty-five years.

Dr. Thomas Andrews, F. R. S., for many years, till 1879, Professor of Chemistry in Queen's College, Belfast, has recently died, in the seventy-first year of his age. He made early researches into the liquefaction of the gases, presided over the British Association at the Glasgow meeting in 1876, and in his address predicted the ultimate solution of the question of liquefaction, which was accomplished a year and a half afterward.



JOHN BENNET LAWES.

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BIOLOGICAL TEACHING IN COLLEGES.*

By WILLIAM G. FARLOW,

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THE general use of the word biology in this country dates from a period scarcely more remote than ten or twelve years ago, and, even at the present day, in spite of the fact that a good many of our schools and colleges announce courses on the subject, and even the newspapers occasionally discuss its popular aspects, the question is not unfrequently asked by persons generally well informed, What is biology? The question is not easily answered, for, if we say that biology is nothing but the essence of botany and zoölogy—which is the fact—then the inquirer not unreasonably asks why we now hear so much about biology, while we formerly heard only of botany and zoölogy, and the inference is that biology is nothing but a fine-sounding word newly coined to take the place of what used to be called natural history. This is in a certain sense true, but biology means rather natural history as it is, than natural history as it used to be, studied. It is to natural history—I use the terms as adopted in this country, without considering what their original application may have been—it is to natural history what reform is in politics: as reform seeks to elevate existing parties by forcing them to correct abuses and to infuse new life by discussing questions of the day rather than past issues, so, under the guise of biology, the attempt has been made to infuse new life into natural history by substituting for the exclusively descriptive study of plants and animals a broader science which shall include also histology, physiology, and the history of development.

* Read before the Society of Naturalists of the Eastern United States.

As a protest against a too narrow view of natural history, biology attracted a large number of advocates in this country, who hoped that the new, or, if you please, the newly named science, would not only enlarge the views of professional and amateur naturalists, but would also furnish a valuable aid in the education of the young. It is not my purpose to speak of the changed aspect of professional and expert studies, viewed from a biological stand-point, but merely to consider the effect which has been produced on elementary instruction in colleges and schools. Within the last ten years a large number of books and papers has appeared in print, intended to show teachers how to teach and students how to study plants and animals. Some of them are excellent, and certainly, as far as books go, they leave little to be desired. They all start with the advice that a beginner should study plants and animals themselves, rather than what has been written about them. In other words, the first thing is to learn to observe. In inculcating the importance of observation the modern biologists are only repeating the advice of the naturalists of the old school, although it must be said to the credit of the former that they have insisted upon observation with a frequency and urgency previously unknown. But how is one to begin? The biological method suggests a careful study of a few types which will give the beginner a general acquaintance with the essential structure of both the animal and vegetable kingdoms; whereas, by the older method, it was the fashion to study rather minutely the external characters of a considerable number of species of certain groups of plants or animals, and the general view of the two kingdoms was obtained, if obtained at all, from lectures, and not from an actual study of specimens in the laboratory.

As I have said, the new mode of study has been more or less in vogue in our leading schools and colleges for about ten years, and we ought to ask, with what success? Has it accomplished what was expected? Or, if not, what is the reason? It has been my lot to teach one branch of biology to college classes, and, as my experience seems to me to show that, in some respects, the result is disappointing, I should like to state some of the difficulties which have presented themselves in my case, not that I have lost faith in the system at all, but because my experience apparently shows that considerable improvement must still be made before the best results can be attained.

The students who come under my charge, about thirty-five annually, are probably in intelligence and industry good representatives of the average student as found in our colleges. They come from all parts of the country, and while many of them have been fitted for college at the different classical schools, where the great object is to prepare boys to answer certain examination questions, education as such being considered of very slight importance, others are fitted in schools where natural science is ostensibly taught, and others still come from distant colleges and technical schools. The course is strictly an elementary one, and no previous knowledge of botany or zoölogy is required. As a fact, a considerable number of the class have studied botany before entering college, and, as others have not, I am able to compare the results of different methods of study in the fitting-schools.

After a few directions concerning the use of the compound microscopes placed before them, some simple material is given them to examine. Considering the large number of good books which insist upon proper training of the observing powers, and knowing how extensively they are read by teachers, I might hope that, at least, a good share of my class would know how to set to work. But what is the case? The first question asked by about three fourths of any class is sure to be, "What do you wish me to observe?" What a question! Is this the result of several years' training, that a young man eighteen years of age, or older, must be told just what to observe when a preparation is put before him? Has it come to this, that, while a boy eight or ten years old will examine with interest objects placed before him, a college student will not examine a preparation until he has been told exactly what he is to see in it? When I reply, "I wish you to examine whatever there is to be seen in your preparation," there is a look of astonishment, sometimes shading off into dismay. That an instructor should expect students to look at an object before them and make out its structure, or attempt to make out its structure, by themselves, seems to them something quite unheard of, and they evidently feel that there is a certain meanness attaching to one who will not tell them just what they must see. It has never entered their heads that, while an instructor may be able to tell them what he himself sees in the object to be studied, he can not tell them what they will see in it, and that it is only after they have studied the object for themselves and attempted to form an idea of its structure that he can explain what is obscure or correct what is erroneous. Evidently the greater part of the students regard the objects placed before them as so many diagrams, and the instructor is to serve the same purpose as the "explanation of figure so-and-so" in a text-book.

The question naturally arises, where were those who ask, "What do you wish me to observe?" fitted for college? Do they all come from the classical schools, where the only natural history studied is a three weeks' cram of Gray's "How Plants Grow"? Unfortunately, they do not. Nothing better, perhaps, could have been expected from schools where nearly all the instruction is confined to languages, and where the inquiring spirit and fondness for observation natural to children, are suppressed to a great extent. Some of the students in question have come from schools, or worse still, from colleges, where natural history is taught, and where use is made of some of the excellent books to which I have already referred. It is evident that a good book is not enough, for there can be no doubt that many teachers take the very books which emphatically urge the necessity of observation, and use them just as they would a grammar, or a school history, so that the observation, in this case, may be said to consist in observing what is said on a certain page of a certain book, and not in watching any plant or animal.

Supposing that I am correct in believing that about three fourths of a class ask the question, "What do you wish me to observe?" there still remain one fourth who do not ask the question. Among these are some who are by nature good observers, or who have been well trained, but the number of these is very small. The remainder consists of those who have already studied biology according to the very latest method with all the modern improvements. They do not ask what I wish them to observe, but, on the contrary, begin to lecture to me about the object under consideration and things in general. If I give them some yeast to examine, they tell me at once all about its history, and show me the spores which it seems necessary that the yeast should have to make it agree with the books. It makes no difference if I substitute a quantity of starch for the yeast. If I only call it yeast, it will have all the book-marks of yeast. This over-educated class of young men is very entertaining, but very hard to teach. Everything is grist to their mill. For them the ubiquitous air-bubble makes a simple but sufficient nucleus, if it is necessary to have a nucleus, or it will serve equally well as a spore if spores are desired. Nothing is so insignificant that they can not apply to it a big name, and no theory is so complex that it can not be dragged in to explain the most self-evident cases.

I have said enough to show that, unless my experience is an exceptional one, in spite of all the talk on the subject, boys at school are not taught to observe as they should be, and that even those teachers who use good text-books frequently use them as means of imparting facts easily and quickly by the old method, rather than as an aid in the scientific training of the faculties which must form the basis of any serious study of biology. One fact has surprised me. Some of the best observers among my students have been persons who fitted at the classical schools, where the training is exclusively linguistic and mathematical. To be sure, they have been considered a bad lot by some of their instructors, and I presume that they paid little attention to their studies at school. Perhaps it is in consequence of this very neglect that their natural powers of observation have been less impaired than those of their fellows who have learned more and seen less.

It seems a great pity that students should come to college so ill-fitted, as are the majority, to undertake biological work. But we must accept things as they are, and there is no use in attempting to take the second step before the first has been taken. If the school can not or will not teach observation, then it must be taught in college, no matter if it does seem to be child's work. In colleges, however, it is absolutely impossible to find the time or the means for training every one to become an observer, and we are obliged to distinguish between two different classes of persons in arranging courses in biology. The first and much the larger class in Eastern colleges includes all those who are preparing themselves for literary, legal, and other similar pursuits, and who wish to know the most important facts about animal and plant life, but who, after they have entered college, can not afford the time to train themselves for strictly scientific studies. This class must of necessity be taught by lectures and, perhaps, a few demonstrations, and, as far as the method is concerned, it is the same as that pursued in teaching literature, history, or other subjects in which general information is sought. Nothing further need be said with regard to biological instruction intended for this class of students, for in several of our colleges the instruction of this kind is distinctly good and constantly improving.

The second class of students includes those who are intending to become professional naturalists, teachers of natural science, or medical practitioners; in short, all who need to know plants and animals practically and the methods of biological investigation. Of course, every naturalist and teacher of natural science should have a practical acquaintance with plants and animals. So, too, should every respectable physician be trained in methods of biological study. To him every patient should be a field of research. By his own powers of observation he is to find out signs and symptoms of which the patient can not or will not give information. Merely listening to lectures, however entertaining or full of information, is not enough for this class of students. Work in the laboratory is necessary, and, in my opinion, that work had better precede any detailed course of lectures.

Being myself merely a botanist, I can only speak of the way in which plant-life may be taught, but, as far as the method of instruction is concerned, what is true of botany is, I presume, essentially true of zoölogy. Considering the age of college students, and the necessity of using the compound microscope, if one intends to make a practical study of biology, it seems to me best that the instructor should begin with some simple form like yeast or a unicellular alga.

There are other reasons besides, which make it desirable to begin with the smaller forms which can only be studied with the microscope. As it is necessary, under present conditions, to begin by teaching a student how to observe for himself, it is better to use for this purpose small forms which he has probably never seen before, or, if he has read books on biology, a mixture of several small forms which he can not recognize from pictures. The plan of recommending any text-book in the beginning is very injurious. If books are used, by far the greater part of any class will, from mere force of habit, commit the contents, and then imagine they see everything mentioned in the books and nothing more. After they have been trained to observe, they may be allowed to consult books, but not before. What is true of books is true of lectures on objects taught in the laboratory. The students always wish to have the lecture first and see the object afterward. It seems to them to lighten the work, but they fail to recognize, what is evident to the instructor, that they are not learning so much or so well.

Again, few students have any proper conception of solid bodies, and, to train them on this point, nothing is so good as some opaque body which has to be studied by microscopic sections. For this purpose I use pieces of pine-wood which are given to the class early in the term, just as soon as they have acquired a little facility in the use of the microscope. A piece large enough to show the annual rings is given to each student, who, by looking at the rings, can tell from what part of the trunk his piece came. After some simple directions about cutting, the student is told to make sections in three directions: at right angles to the trunk, and in the directions of the radius and tangent, and in the order named. After they have made and drawn the first section, if asked what they think is the structure of the wood, almost all of them will at once say that it is composed of square cells. If one asks what they mean by square cells, they say cells shaped like dice. In classes of from thirty to forty persons, I have never found more than four or five students—in one class there was only one—who knew enough to say that they could not tell what the structure of the wood was until they had seen sections in other directions. The cross-section made, they proceed to the radial section. Having already made up their minds from the cross-section that the wood is formed of cubical cells, the radial section, with its long tubes showing the peculiar disk-like markings of coniferous wood on the walls, utterly confounds them; and it requires considerable time before they give up the attempt to make what they see in the radial section agree with the cubical cells which exist only in their own imaginations, and realize that it is only by mentally combining the transverse and radial sections that they can arrive at any correct conception of the structure of the wood. Finally, the disk-like markings are to be explained. After trying ineffectually to pass them off as nuclei, vacuoles, or other structures which they have heard are to be found in vegetable cells, they are finally induced to see whether they can not find any traces of them in the other section, and so, slowly, they make out their real nature.

No work which I ever have to do as an instructor is so utterly dreary as that of forcing students to have a correct conception of solids. It is really a lesson in solid geometry; a subject which, as we all know, many persons can only learn with great difficulty. But, difficult or not, the training in this direction is so important that it warrants the amount of time and labor spent. As a rule, I fear, classes do not see why I give them pine-wood to study. They dislike the work very much, and feel that they have learned comparatively little. If the only object were to know the structure of pine-wood, I could tell them that in a few moments. What they have learned, without being aware of it at the time, is the way to examine solid, opaque bodies, a category including by far the greater part of biological structures. Once done with the pine-wood, progress is always comparatively rapid, and I can only conclude that the classes are strengthened by the work done on the wood.

I need not occupy your time with any further account of what can best be taught in laboratories to beginners. There is nothing to be said against the plan laid down in the manuals in common use, provided the student is not allowed to follow it mechanically, and look at nothing which is not mentioned in the book. A good instructor is, of course, so well informed about the subject he teaches that he can turn almost any material to account. In my own case, it would be very inconvenient to furnish the same material year after year ; but almost anything can be used to illustrate the typical modes of growth and reproduction in the vegetable kingdom, which is what the beginner needs to know.

There are, however, a few points to be considered, which bear on the relations of the instructor to the student in college classes. It should be borne in mind that one is not dealing with school-boys, but with young men who, if they are as ignorant of biology as school-boys, have, however, learned other things, and whose development, obtained from studies at school, so far from making them better able, has, in the majority of cases, made them only the less fit to take up biological studies. If they have much to learn, they have also something to unlearn. They have been taught to rush at a fact as a bull rushes at a red rag—for the purpose of tossing it away immediately. The position of the instructor is not an easy one. He is under constant restraint, as he must not tell the student, but must, if possible, make the student tell him, the structure of what lies before him. He is in the position of a boxing-master, who might easily floor his pupil by a single blow, but who must, by the exertion of great prudence and skill, contrive to let the pupil hit him. By a judicious series of questions, suggestions of possibilities or alternatives, the student may be kept in the right track and yet do all the work of advancing toward the truth himself. Under no circumstances should an instructor let a student, who is a beginner, discover what his own views are about any point to be studied. Although they may be wretched observers of natural objects, it does not follow that students are not good judges of human nature. Without any instruction they manage to become adepts in that direction. They often hope, by the exercise of ingenuity in detecting allusions to what they are studying, in remarks carelessly made by the instructor, to find out what his pet ideas and theories are. And where is the instructor who is not pleased to find his own favorite opinions ardently, and, as it seems, independently indorsed even by a student?

Another difficulty is the almost universal habit which students have of using technical or semi-technical terms which, in reality, convey to them no idea whatever. They think they have comprehended the *thing* when they christen it with a high-sounding *name*, and they do not stop to ask themselves whether they understand what the name means. The student who called a hole in a cell-wall a bioplast was quite pleased with his achievement until he was asked what a bioplast was. The suggestion that a hole might, without any great violence to the English language, be called a hole, was timely if not pleasing. Evidently, for an educated man, the art of calling a spade a spade is difficult to acquire. Day after day, one is obliged to ask students to translate their lingo—I don't know what else to call it—into English. Frequently they can not. At length they begin to see that they are only deceiving themselves by using words which they do not comprehend to describe structures which they do not understand. It frequently happens that, after a student has described an object under the microscope in what he considers fine scientific language, he admits that he does not understand the structure of the object at all, but, on making him start over again, and describe it in plain English, he finds that it all comes out clearly enough. It is evident, for instance, that, so long as a student thinks he must call all round bodies in cells nuclei, he will soon have such a stock of nuclei on hand that he will be hopelessly confused, and the matter is not much improved if, as a last resort, he indiscriminately calls some of his superfluous nuclei vacuoles and others bioplasts. The tendency to use meaningless words is not, by any means, confined to biological students, but, in a laboratory where one is examining something definite, the evil should certainly be checked by frequent demands for English translations of verbose rubbish.

In giving you a somewhat detailed account of my own experience, gentlemen, I am probably saying nothing new to you. It is an old story, and perhaps a monotonous one. If I have spent considerable time in stating the difficulties in the way of college instruction, it is because I see that we must first have a clear conception of what the difficulties are before we can make any real progress. The most serious obstacle, it seems to me, is not so much that boys are not taught biology at school, as that they are not taught to observe, but are, on the other hand, taught to memorize text-books, and to regard education as the acquiring of facts in the most rapid and easiest way. It is a mistake to suppose that he is the best teacher who gives the most information in the shortest time with the smallest expenditure of labor on the part of his hearers. Such a teacher fails in a most important respect. The pupil under his guidance becomes a passive recipient of knowledge, and is not trained to rely on himself or to become an active worker in any direction. Patting one on the back and saying, "Don't you see this?" and "Don't you see that?" does not tend to produce a very robust mental development. You can not make a boy a good mountain-climber by carrying him up the Mount Washington Railway, no matter at how rapid a rate; and, in ordinary life, there are many mountains to be climbed, up which there is no railway.

As far as I can judge from the qualifications of students who come under my instruction, the schools have within the last six or seven years made no perceptible progress in training the observing powers. The good advice given and the good text-books by competent authorities have not, as yet, produced any marked effect. As far as elementary training is concerned we are about where we were ten years ago. The college-instructor must still regard the student who studies under him as a school-boy whose capacity for observing and investigating natural objects has been blunted by a one-sided course of instruction at school. Hence we are still under the necessity in college courses of beginning at the very beginning, and, if there is any mistake in our colleges, it is that the instruction in biology is pitched in too high a key. For those who are to study practically animal and plant life it is better to stick to commonplace topics for a year or two, and insist upon the careful examination of living plants and animals, before proceeding to an elaborate discussion of theories which, however great their value to mature scientific minds, would easily lead a beginner into mere vague speculation. The distinction between lecture courses for the general information of those who are not intending to enter pursuits which demand practical training in biology and courses for those who do need such training should be carefully adhered to. Again, an instructor should not hurry with his elementary classes. Knowing how much there is to be learned, he naturally feels obliged to teach as much as possible. But it is better to be slow and sure in the beginning, and, if necessary, hurry at a later stage.

One serious difficulty under which our colleges labor in laboratory instruction is the lack of a sufficient number of suitable assistants. This is not usually because properly qualified assistants can not be obtained, but because they can not be obtained for the salaries which are usually paid. In teaching elementary classes of from twenty-five to fifty persons in branches requiring the use of the compound microscope, one assistant is not enough. To do the work properly, at least two, and, better still, three assistants are needed, supposing, as is generally the case, that all the work is done on three days of the week.

The question arises whether we are ever to expect that the elements of biology will be properly taught in schools. At present there are very few schools where they are well taught, and information is lacking to show that the number is increasing. Good books exist, but books are only of secondary importance, and certainly good teachers are few indeed. The improvement in the quality of college graduates who could teach biology in schools, if there was any demand for it, gives room for hope. Under the present fashion of cramming for college there is not much to hope for in the ordinary fitting-schools, and it would be much better if they abandoned altogether the very palpable sham which they now call botany. More could probably be accomplished in the grammar and primary schools where there is more time, and where the pupils are of an age when they naturally feel interested in plants and animals. Of course, in such schools one should begin with the larger flowering plants and not attempt to use the compound microscope. Certainly, in schools in the country or in places where the children frequently see plants growing, botany, if well taught, would be admirably adapted for awakening and developing the spirit of observation and investigation. In large cities the case is somewhat different. There the children hardly ever see plants growing, and the expense of providing them with the few flowers shown at school is hardly warranted by the good derived therefrom. As the main object is to acquire the power of observing, I am by no means certain that, in large cities, physics, or at least mechanics, may not prove to be better adapted to the purpose than botany or zoölogy.

DISCRIMINATION IN RAILWAY RATES.

By GERRIT L. LANSING.

II.

HAVING already considered those discriminations affecting persons and things, there now remains the consideration of rates affecting places.

All discriminations favoring places result from the competition existing at the favored points. This is of several kinds: First, the competition of parallel railroad lines or water-routes; second, the competition of markets; and, third, the efforts of the railroad company to increase its profits by increasing its traffic at lower rates. These operate sometimes singly, sometimes by more than one, sometimes all together. They also exist in different proportions, and so the direct effect of one or the other can not, in most cases, be measured.

I. The competition of parallel lines or water-courses includes those cases where two or more points on a railroad are accessible also by another railroad or water-route. The struggle for the traffic of such a place results in lower rates than to places less favorably situated.

If the competition is between railroads alone, the conditions of their service being approximately equal as to cost, agreements are made to abide by established tariffs, and such tariffs may be but little lower than to non-competitive points. There is, then, but little discrimination. But sooner or later the struggle for the traffic leads one road to cut the tariff rates; the other retaliates by a greater cut, and this often ends in a reckless war of rates. After the excitement of such a contest has somewhat passed away, the injuries inflicted become more felt, till at length reason leads to a restoration of the tariffs. During such a contest there is an unreasonable discrimination, as the rates are frequently less than the cost of the service. The only solution of the problem which has yet been found is to remove the incentive to cut the rates by fairly dividing the traffic between the competing lines. The common method of accomplishing this is to pool the receipts and to redistribute them on percentages based upon experience and decided by an arbitrator. This is the only instance, so far as I am informed, in which the natural principles regulating the rates of transportation lead to an unjust discrimination; and in this case the loss to the railroads, by carrying the traffic for less than cost, is perhaps greater than the injury to the community by the disturbance of values and oversupply which accompanies such contests.

So far, then, as the competition at a given place between railroads alone is concerned, the discrimination is regulated to a great extent by the harmonious working of the roads themselves. In competition with water-routes, however, on account of the inequality of their circumstances as to the cost of the service and the ease of adding new competitive boats, a discrimination must always exist. It is beyond the power of the railroad or any person or other body to prevent it, except by the heroic remedy of interdicting the traffic by rail. The water-route is free to all, its highway is furnished by nature, and the carriage is the only item of cost which must be borne by the traffic. The railroad company, on the other hand, has two existences: it is the owner of a public highway, and is a common carrier. The rate of transportation is thus composed of the toll for the use of the highway, and the charge for the service of carriage. This is a distinction which is not made in the popular mind, though it is always recognized by the law, and is important to bear in mind in the present instance; for it affords a justification of the discrimination made in favor of places having water competition, besides that contained in the necessity of the discrimination to secure the traffic.

We may take first the simple case of those places having no unusual amount of traffic, and located anywhere on the line of road, either local stations or through points; the only peculiarity about them being that they are on a competitive water-route. In those other cases where the favored places are great markets as well as competitive points, the problem becomes more complicated and will be considered afterward. On many large railroads there are stations of no particular importance in size, which may also be reached by a river or by the sea. As they are not markets for any considerable territory, but have grown from restricted local requirements, they are not to be compared with other important depots on the same water-route. Such a place offers no more traffic to the railroad than many other local stations to which the railroad is the only means of transportation. The argument then, that the railroad should reduce its rates on account of an unusually large traffic, is foreign to the fact. The shippers simply demand that rates shall be unusually low, or the traffic will take the route by water. The terms offered to the railroad are, to take the traffic, say for illustration, at one half the rates which are charged to other places on the road of equal distances, or not to take it at all. Now, in considering the discriminations between things, we have seen that in taking traffic thus offered as compared with not taking it, the only items of expense which would be affected are connected with the cost of carriage. In either case the fixed charges must be borne by the remaining traffic. And we have also shown, in illustration, that the fixed charges in the average case may be roughly stated at two thirds of the total cost, so the traffic offered at half rates would afford a small profit above the cost of carriage. To the railroad, then, the case resolves itself into the simple question whether it will take what it can get, or go without. There is no hesitation as to the decision: the rate demanded is given from necessity.

That this is a source of no injustice to the less fortunately located places is shown from their history. Before the construction of the railroad the non-competitive points—or as many as existed at that time—were supplied with transportation solely by the slow and expensive means of animals and wagons. The construction of the railroad reduced the time and the cost of transportation to a fraction of the former amount. Along the line new towns sprang up, and both the old and the new increased in population and prosperity by the impulse to production and industries furnished by cheaper and quicker transportation. By the construction of the railroad the places which existed before increased many times in wealth and population; while to the same cause the numberless other places owe their existence. These facts are among the most prominent of the unprecedented material development of this country during the last half-century. The railroad has been to the inland places of immeasurably more benefit than to any others. It is, in fact, for these that it was constructed. The places on the water-routes were already supplied with a cheap and sufficiently rapid means of transportation; they were but incidentally passed by the railroad in the course of its extension. With the water-route the highway is furnished by nature, to the inland place it is supplied by man. The traffic must in each case alike pay the cost of carriage; but, the water-route being free to all, no toll to points on it can be charged on any highway. As the railroad was not built for the traffic of such points, which were, before its construction, provided with transportation facilities, but was for those places to which the highways of nature did not extend, there seems no injustice in charging the expenses of the highway to the places for which it was constructed.

It is sometimes stated that non-competitive points should have rates as low as are made to competitive points; and the reason is repeated that the latter rates, which are voluntarily made by the railroad, being presumably fair, it follows that the former rates, being higher, are unfair. But, if the traffic between all points paid but the cost of carriage, there would remain no provision for the highway and the necessary fixed charges. A rigid rule, then, preventing the discrimination between these places would leave the railroad the alternative of raising the rates at the competitive points, thus losing that traffic altogether; or reducing to a little more than the cost of carriage the rates at the non-competitive points, and so losing the greater portion of its income.

II. The competition in markets is a second cause of discrimination between places. A market, to be such, must be accessible from sources of supply. Its facilities for transportation must then be in proportion to its importance. Now, the great market cities of the world were established before the application of steam to transportation by land. It is a familiar fact that the commercial cities of the world are either on rivers or the sea; so it follows that the markets come in competition with water-routes, and usually also in competition with other railroads. But the competition is more than by parallel routes carrying traffic for equal or nearly equal distances. To reach the market at all with an article produced on the line of a railroad, it must be carried at a low enough rate to enable it to be sold in competition with the same article produced perhaps much nearer the market. Grain carried five hundred miles can sell for no more than grain carried fifty miles, and, if the conditions of production are the same, the carrier must place them on an equality as to transportation. A long haul has thus to compete with a short haul, or abandon the market. If discriminations in favor of markets were not permitted, no grain could go *by rail* from Chicago and the West to the Atlantic seaboard and to Europe. But the discrimination would be made as it always has been made by the water-routes through the lakes and the St. Lawrence or Erie Canal, or down the Mississippi to New Orleans. The water-routes, however, have not an equal interest in developing the country that the railroads have; and, without the competition introduced by the latter, the rates by water would be greater than they are, and the countries whose shores they wash would be comparatively undeveloped. The railroad, in developing the resources of the country which it serves, not only secures thereby more traffic, which at the time adds to its net income; it increases as well the value of all its property. The highway being made by the railroad, and representing a large investment, a wise policy leads to the establishment of such rates as will add to its permanent value. A temporary rate at but the cost of carriage, if necessary to establish or develop an infant industry which would in future furnish a profitable traffic, is thus justified by self-interest. To a steamer or vessel on the lakes, on the other hand, the development of the surrounding territories means but additional competition; an increase of traffic is met by an increase of boats. Their policy is to take from the traffic at the time all that can be secured, for to-morrow it will be carried by some one else.

The new supply brought to the market from a distance reduces the selling price of the article in the market, a result unfortunate to those producers nearer the market, who theretofore monopolized the trade, but fortunate for those at a greater distance who would otherwise have no market, or a more restricted one, for their products. The more important result, however, is to the general public, who are benefited through the discrimination by a reduction in the cost of the necessaries and common comforts of life; for the articles carried to the market in the greatest quantities are those which are consumed in the greatest quantities—they are the necessaries and common comforts; and, as has been already shown, it is in favor of these things particularly that discriminations are made.

III. A third cause of discrimination between places is found in the volume of the traffic. The effort of the railroad to increase its profits, by increasing its traffic through the incentive of lower rates, has already been dwelt upon in considering discriminations between things. It affects places as well. It is the principle of development, and so works upon all the traffic of a railroad and between all places. But it affects most those things or places in which there is the possibility of the greatest development. A familiar illustration of the operation of this rule is the suburban passenger traffic which has been already mentioned. The possibility of developing the travel between a great city and its suburbs is practically unlimited; accordingly every incentive is offered as to frequent and rapid trains and low rates. But between two small towns the same service and rates would be a manifest absurdity. No possible inducement, short of a payment to the passenger instead of a charge, could make any material increase in the travel, except that which slowly results from the natural increase of wealth and population. Similar causes affect the rates on freight. As things consumed in the largest quantities, in which the traffic is most capable of development, are the most favored as to rates, so also are places which consume or are markets for the greatest quantities of things. In all cases when discriminations of this nature are made in freight rates, it is where the lower rates will afford a larger net profit than the higher rates, by an increase of traffic in a greater ratio than the increase of expense. Such low rates, then, can not be at the expense of higher rates to other places. Though they may be below the average rate of cost of the entire traffic, they are never knowingly less than the *cost of carriage* of the particular traffic.

These several causes requiring discrimination between places, viz., parallel roads or water-routes, competition of markets, and the efforts of the railroad to increase its profit by increasing its traffic at lower rates, are, in the popular mind, considered without distinction; the discrimination is as to through or local traffic. This distinction is in accord with the usual result, for through points are, in nearly all cases, the places where the most active competition of all kinds is in force. The usual termini of railroads are large cities; these again are usually on water-courses, and are usually also the chief markets reached by the road. But such is not always the case, and, when it is not, the rates will be found to be modified in accordance with the number of these forms of competition there in force, and the greater or less strength with which they exist.

This general classification of the traffic into through and local suggests a further reason why the competitive rates might fairly be expected to be lower than the local. Through points—the termini of the road—afford the longest haul, and traffic carried a long distance is, like that carried in large quantities, at a lower rate of cost per mile than that carried shorter distances. The traffic between terminal stations is usually much greater than that between any other two stations; cars are therefore loaded to their full capacity. The load at the end of the long haul is discharged, and with a delay of perhaps a day may be loaded again and returned. The local traffic is in small quantities, the car is but partly loaded, or if fully loaded the delay in unloading is as great as though it went through to the terminal station. The way-station, in the large majority of cases, affords no return load, so that the haul to some station where the car is needed, as well as the delay caused thereby, must be added to the expense. Add to these differences the difference in the volume of the traffic, and it will be readily seen that the cost per mile on through can not be but a fraction of what it is on local traffic.

Although the constant play of these competitive forces results in reducing through rates to a very low point, it deserves to be noticed that in local rates there is as well a constant though less rapid tendency to reduction. Wherever no more active forces of competition are in operation, the effort on the part of the railroad to develop the production and resources of the country by stimulating rates, and so increasing the profits and the value of the property of the company, is a cause which works constantly toward reductions. This fact is illustrated by the Railroad Commissioners of Iowa, who, in their report for 1881, occupy forty-six pages with tables and statements showing the reductions in rates in that State, and in which they particularly call attention to the fact that "the reduction is not confined to the through traffic; it applies, in a somewhat smaller ratio, it is true, to the local traffic as well" (p. 7). And they conclude their remarks upon the subject as follows: "We venture to say that this average percentage of reduction for the last fifteen consecutive years will be a matter of no little surprise to everybody who does not make the study of freight tariffs a somewhat regular habit. Although we have made no calculation to demonstrate it, we venture to affirm that an equal average reduction in the cost of any kind of service for which the people pay a money consideration can not be found during the past fifteen years" (p. 35).

It will be seen from the foregoing that discriminations affecting places are made by nature. The distribution of land and water on the face of the earth produces a discrimination against inland places and in favor of those located on water-courses or the sea. The accessibility or inaccessibility of these places on the highway furnished by nature is the basis of the discriminations affecting them on the highway supplied by man. The rapid and cheap communication afforded by railroads has introduced a strong competitor to the water-routes, and has to a great degree reduced the inequality established by nature. But with the water-routes the highway is supplied without cost, its use is free; the *carriage* only is a charge upon the traffic. The cost of transporting by water is thus cheaper than by land, and this must always prevent the local inland rates by rail from being as low as the rates on the free water-routes.

If rates are not to be based on the principles by which, in compliance with the demands of commerce, they have heretofore been determined; if those discriminations only are to be considered fair which are based on the bulk and destructibility of articles; then the single rule remaining to apply to the discrimination of rates is that of distance—the mileage basis.

The advocates of State interference in the regulation of rates seem to be possessed with the conviction that the true basis of charge is the cost of the service, and they labor under the common error that the mileage basis is a practical method of determining this. It will be found, however, that the rates determined by the operation of commercial requirements will coincide more nearly with the cost of the service than can be the case with any artificial system which does not recognize, as elements fairly affecting rates, the value of the service, the volume of the traffic, and the competition of other routes. If the railroad is not allowed to take traffic, which can not afford to pay the standard rate, at whatever rate it can afford, if it charges more for certain traffic than the value of the transportation to the shipper, that traffic is lost. Now, the traffic that can afford to pay but very low rates is composed of things that are of low price; such, as I have already mentioned, are the necessaries of life. These things form a much greater portion of the company's traffic than any other equal number of articles. Grain, for instance, from the fields of production in the West is carried to Chicago or St. Louis entirely by car-loads, and is forwarded thence by the train-load. Coal, petroleum, and provisions in some cases afford a regular traffic by the train-load. These articles being carried in large quantities are, as has been shown, carried at a much less rate of *cost* than things shipped in small quantities. The cost of the service thus bears an approximate relation to the rate of charge. Again, the volume of the traffic is a cause of discrimination, if by reducing the rate the traffic can be sufficiently increased to produce a greater net profit. And, again, it follows that the rate of *cost* decreases with the reduced rate of *charge*. In the reduction to meet the competition of other lines to the same market, the discrimination is also made to get the traffic which could not otherwise be secured. And the result, again, is a reduction in the rate of cost of the service by the greater traffic usual to those markets or centers of industry which are favored by the discriminating rate.

Indeed, it has sufficiently appeared that all discriminations are made to increase traffic, and those things and places are favored most which furnish the largest traffic. Now, as a larger traffic is carried at a less rate of cost, it follows that there is a constant and fundamental relation between the cost of the service and the rate of charge. There is, in fact, as close a relation as it is possible to establish between them by any system but one which would be prohibitory to a great portion of the traffic. The mileage basis of rates, however, has and continues to find many advocates, yet its impracticability has been so often illustrated that but brief mention of it seems here to be called for. Where all circumstances of value, cost, competition, and quantity are equal, a mileage rate is now applied by railroads, only reducing the rate per mile gradually as the length of haul increases, thus making the rate conform more nearly to the cost of service than if the same rate per mile were applied for all distances. This is as near as it is practicable to apply the principle, and is the rule so far as my information extends on all American roads, as it is also on European roads, operated both by private corporations and by governments. But where the circumstances of cost, competition, quantity, and value are different, that is, for the greater portion of the traffic, the principle would result in prohibition. From the preceding pages this result appears to me so apparent as to need no further comment. A statement before me, however, of an impartial and informed body (the select Committee of the Parliament of Great Britain on fares and rates of 1882), is so clear and forcible an exposition of this point, and at the same time affords an illustration of much that has herein been said on the subject of discrimination in general, that I am led to make from it the following quotation: "The form which the proposal for a fixed standard of charges has usually taken is equal mileage, i. e., a charge for each class of goods and passengers in proportion to the distance for which they are carried." This point was strongly urged before the Royal

Commission, and is so effectually disposed of by their report that it seems scarcely necessary to dwell upon it further. But it reappears in the evidence of some of the witnesses before this committee, and it may therefore be desirable to state shortly why it is impracticable:

"'(*a*.) It would prevent railway companies from lowering their fares and rates, so as to compete with traffic by sea, by canal, or by a shorter or otherwise cheaper railway, and would thus deprive the public of the benefit of competition, and the company of a legitimate source of profit.

"'(*b*.) It would prevent railway companies from making perfectly fair arrangements for carrying at a lower rate than usual goods brought in larger and constant quantities, or for carrying for long distances at a lower rate than for short distances.

"'(*c*.) It would compel a company to carry for the same rate over a line which has been very expensive in construction, or which, from gradients or otherwise, is very expensive in working, at the same rate at which it carries over less expensive lines.

"'In short, to impose equal mileage on the companies would be to deprive the public of the benefit of much of the competition which now exists, or has existed, to raise the charges on the public in many cases where the companies now find it to their interest to lower them, and to perpetuate monopolies in carriage, trade, and manufacture, in favor of those rates and places which are nearest or least expensive, where the varying charges of the companies now create competition. And it will be found that the supporters of equal mileage, when pressed, really mean, not that the rates they pay themselves are too high, but that the rates that others pay are too low. Pressed by these difficulties the proposers of equal mileage have admitted that there must be numerous exceptions, e. g., where there is sea competition (i. e., at about three fifths of the railway-stations of the United Kingdom), where low rates for long distances will bring a profit, or where the article carried at low rates is a necessary, such as coal. It is scarcely necessary to observe that exceptions such as these, while inadequate to meet all the various cases, destroy the value of equal mileage as a principle, or the possibility of applying it as a general rule.'"*

Tariffs of rates have, however, been established without discrimination, but their workings have shown that they were established with as little discretion as discernment. An illustration of such a case is afforded by the experience of Germany, the history of which is given in the testimony before the committee on fares and rates of the Parliament of Great Britain above referred to. The Government, in conformity with its military spirit, which admits of only unquestioning obedience to arbitrary orders, enforced on the railways a uniform and unvarying system of charges. Having fixed the tariffs in its own

* Report to the House of Commons, July, 1882, p. ix.

country at rates which to it were satisfactory, it adopted the principle that no through rates should be given except on the basis of these local charges. Thus traffic, for instance, between Belgium, or Holland and Austria, might be brought up to the German frontier at whatever rate those states chose to fix, but, immediately upon entering on German territory, the local tariffs should apply. As a result, the through traffic was driven from the railroads to the rivers, and exports from Austria found their way to the sea on the Elbe and the Rhine. After the enforcement of the policy had "utterly destroyed" this through traffic on the German railways, the administration decided to profit by the experience to abandon their unnatural policy, and attempt to get back the traffic. Accordingly, they issued a tariff, which is instructive as showing how completely they gave up their artificial system and recognized in railway rates the natural forces controlling commerce. The heading of the tariff reads: "Exceptional tariff to and from the German seaports, for goods traffic between Hamburg, Harburg, Bremerhaven, Geestemünde, Bremen, and Regensburg, and Passau stations. To come in force on and from March 1, 1882. This tariff will apply only to goods traversing Germany and passing beyond Regensburg and Passau, and out of the district of the German customs, and in consignments of ten tons per truck and above (wool excepted). Smaller consignments will be charged at usual rates. Articles included in the exceptional tariff." It then continues to enumerate articles under seven "special tariffs." The testimony before the commission on this subject concludes as follows: "Now that shows that the strongest government in the world, I suppose, can not interfere with the course of traffic except at its peril, and, if they attempt to impose upon the commerce of the country an impossible system, they come to grief." *

I have attempted to show that the rates on railroads are regulated by natural principles of competition, and that it is from the operation of these principles that discriminations are produced. This is but saying, in other words, that discriminating rates result from competition. An examination of the cases reported by the various State Railroad Commissioners will show that this is true; for it will be found that the discriminations effect a reduction in rates, not an increase. They are concessions made to secure traffic, which at former rates would not be carried. If this were not at least believed to be the result, there would appear no incentive for the company to make the reduction. In brief, the cause of discrimination is competition, the effect is reduction.

* Report to the House of Commons, July, 1882, pp. 170, 171.

A THINKING MACHINE.

By GRANT ALLEN.

"THINGS marvelous there are many," says the Attic dramatist, "but among them all naught moves more truly marvelous than man." And, indeed, when one begins seriously to think it over, there is no machine in all the world one-half, nay one-millionth part, so extraordinary in its mode of action as the human brain. Minutely constructed, inscrutable in all its cranks and wheels, composed of numberless cells and batteries, all connected together by microscopically tiny telegraphic wires, and so designed (whether by superior intelligence or evolutionary art) that every portion of it answers sympathetically to some fact or energy of the external universe—the human brain defies the clumsy analysis of our carving-knife anatomists, and remains to this day a great unknown and almost unmapped region, the *terra incognita* of modern physiology. If you look into any one of the ordinary human machines, with its spokes and cogs, its springs and levers, you can see at once (at least, if you have a spark of native mechanical intelligence within you) how its various portions are meant to run together, and what is the result, the actual work, to be ultimately got out of it. But not the profoundest microscopist, not the acutest psychologist, not the most learned physiologist on earth could possibly say, by inspecting a given little bit of the central nervous mechanism of humanity, why the excitation of this or that fragment of gray matter should give rise to the picture of a brown umbrella or the emotion of jealousy, why it should rather be connected with the comprehension of a mathematical problem than with the consciousness of pain or the memory of a gray-haired, military-looking gentleman whom we met three years ago at an hotel at Biarritz.

Merely to state these possible alternatives of the stimulation of a portion of the brain is sufficient to bring up vividly into view the enormous and almost inconceivable complexity of that wonderful natural mechanism. Imagine for a moment a machine so delicate that it is capable of yielding us the sensation of a strawberry-ice, the æsthetic delight of a beautiful picture, the intellectual perception of the equality of the angles at the base of an isosceles triangle, the recollection of what we all said and did the day we went for that picnic to the Dolgelly waterfalls, the vague and inconsistent dissolving views of a disturbed dream, the pain of toothache, and the delight at meeting once more an old friend who has returned from India. The very mention of such a complicated machinery, let alone the difficulty of its possession of consciousness, is enough to make the notion thus nakedly stated seem wild and absurd. Yet there the machine actually is, to answer bodily for its own possibility. You can not cavil at the accomplished fact. It may be inconceivable, but at any rate it exists. Logic may demolish it; ridicule may explode it; metaphysics may explain it away; but, in spite of them all, it continues still imperturbably to be, and to perform the thousand-and-one incredible functions which argument conclusively and triumphantly demonstrates it can never compass. Call it materialism or what else you like, experimental physiology has now calmly demonstrated the irrefragable fact that on the brain, and on each of its parts, depends the whole of what we are and what we feel, what we see and what we suffer, what we believe and what we imagine. Everything that in our inmost souls we think of as *Us*, apart from that mere external burden, our body, is summed up in the functions and activity of a single marvelous and inscrutable organism, our human brain.

But, though physiology can tell us very little as yet about how the brain does its work, it can nevertheless tell us something; and late researches have made such a difference in our way of looking at its mode of activity, and have so upset many current and very crudely materialistic errors, that it may perhaps be worth while briefly to state, in popular and comprehensible language, how the organ of thought envisages itself in actual working process to the most advanced among our modern physiological psychologists.

Let us begin first with the old-fashioned and, as we now believe, essentially mistaken view—the view which found its fullest and most grotesque outcome in the spurious science of so-called phrenology, but which still lingers on, more or less carefully disguised, among the "localizations" and "specific energies" of many respectable modern authorities.

According to this superficial view, overtly expressed or implicitly suggested in different cases, each cell and ganglion and twist of the brain had a special function and purpose of its own to subserve, and answered to a single special element of sensation or perception, intellect or emotion. In a certain little round mass of brain-matter, in the part of the head devoted to language (if we push the theory to its extreme conclusion), must have been localized the one word "dog"; in the next little mass must have been localized "horse"; in the next, "camel," in the next again, "elephant," and so on *ad infinitum*. Here, a particular cell and fiber were intrusted with the memory of the visible orange; there, another similar little nervous element had to do with the recollection of the audible note *C* flat in the middle octave of a cottage piano. Thus reduced to its naked terms, of course, the theory sounds almost too obviously gross and ridiculous; but something like it, not quite so vividly realized or pushed so far into minute detail, was held not only by the old-fashioned phrenologists, but also by many modern and far more physiological mental philosophers.

When we come to look the question in the face, however, the mere number of cells and fibers in the human brain, immense as it undoubtedly is, would surely never suffice for the almost infinite variety of perceptions and facts with which our memory alone (not to mention any other mental faculty) is so abundantly stored. Suppose, for example, we take merely the human beings, living or extinct, with whose names or personalities we are more or less fully acquainted, and try to give a cell or a fiber or a ganglion to each; how many cells or fibers of ganglia would be left unappropriated at the end of the enumeration for all the rest of animate or inanimate nature, and all the other facts or sensations with which we are perfectly familiar, to say nothing of emotions, volitions, pleasures, pains, and all the other minor elements of our complex being! Let us begin, by way of experiment, with Greek history alone, and try to distribute one separate nerve-element apiece to Solon and Periander, to Themistocles and Aristides, to Herodotus and Thucydides, to Zeuxis and Pheidias, to Socrates and Plato, to Æschylus and Sophocles, to Aristides and Alexander, and so on straight through down to the very days of the Byzantine Empire. Then let us begin afresh over again, and give a cell all round to the noble Romans of our happy school-days, Romulus and Remus (myth or reality matters little for our present purpose), the seven kings and the ten decemvirs, the Curtius who leaped into the gulf and the Scævola who burned his hand off in the Etruscan fire, those terrible Scipios and those grim Gracchi, our enemy Horace with his friend Mæcenas, and so down through all the Cæsars to the second Romulus again, pretty much where we originally started. Once more, apply the same thing to English history, and allot a single brain-element apiece to everybody we can remember from Cerdic of Wessex to Queen Victoria, from Cædmon the poet, through Chaucer, Shakespeare, Milton, and Pope, to Tennyson, Swinburne, and Oscar Wilde—a cell each for all the statesmen, priests, fighters, writers, thinkers, doers, and miscellaneous nobodies whom we can possibly recall from the limbo of forgetfulness, from the days when Hengist and Horsa (alas! more myths) drove their symmetrical three keels ashore at Ebbsfleet, to the events recorded for our present edification in this evening's newspaper. (And observe in passing that, out of deference to advanced Teutonic scholarship, I have simply flung away Caractacus and Boadicea, Carausias and Allectus, and all the other vague and vaguely-remembered personalities of the earlier British and Romano-British history.) Why, by the time we had got through our historic personages alone, we should have but a very scanty remnant of places for the thousands and thousands of living individuals with whom each one of us must have come in contact, and each of whom seems to occupy a separate niche or distinct pigeon-hole in the endless archives of the particular memory.

And this is only a single small department of the possibly memorable, a mere specimen category out of an innumerable collection that might equally well have been adduced in evidence. Take the animal world, for example—the creatures themselves, and not their names—

and look at the diversity of cats and dogs, goats and sheep, beetles and butterflies, soles and shrimps, that even the ordinary unlearned man knows and recognizes, and mostly remembers. Narrow the question down to dogs alone, and still you get the same result. Consider the St. Bernards and the mastiffs, the pugs and the bull-dogs, the black-and-tans and the King Charlies, the sheep-dogs and the deer-hounds, the shivering little Italian greyhounds and the long dachshunds that you buy by the yard. Every one of these and countless others has got to have its cell all to itself in the classificatory department of the human brain, and I suppose another cell for its name in the portion specially devoted to language also. Add to these the plants, flowers, fruits, roots, and other well-known vegetable products whose names are familiar to almost everybody, and what a total you have got at once! A good botanist, to take a more specific case, knows (in addition to a stock of general knowledge about equivalent on the average to anybody else's) the names and natures of hundreds and thousands of distinct plants, to say nothing about innumerable small peculiarities of stem, and leaf, and flower, and seed in every species and variety among them all. No, the mere bare weight of dead fact with which everybody's memory is stored and laden defies the possibility of reckoning and pigeon-holing. Make your separate dockets ever so tiny, reduce them all to their smallest dimensions, and yet there will not be room for all of them in the human brain. The more we think on it, the more will the wonder grow that one small head can carry all that the merest infant knows.

And now observe once more in turn a still greater and more fatal difficulty. I have spoken throughout, after the manner of men, as though each separate object, or word, or idea had a clearly defined and limited individuality, and that it could be distinctly located and circumscribed by itself in a single solitary isolated cell of the nervous mechanism. But in reality the very terms I have been obliged to use in describing the matter have themselves contained the implicit condemnation of this crude, hard, and impossible materialistic conception. For no idea and no word is, as a matter of fact, so rigidly one and indivisible, like the French Republic. Take for example once more our old friend "dog," and let us confine our attention just now to the word alone, not to the ideas connoted by it. Dog is not one word: it is a whole group and set of words. There is, first of all, the audible sound, dog, as it falls upon our ears when spoken by another. That is to say, there is, *imprimis*, dog auditory. Secondly, there is the muscular effort, dog, as it frames itself upon our own lips and vocal organs when we say it aloud to another person. That is to say, there is, *secundo*, dog pronounceable. Thirdly, there is the written or printed word, dog, DOG, in capitals or minuscules, script, or Roman, or italic, as we recognize it visibly when seen with our eyes in book or letter. That is to say, there is, *tertio*, dog legible. Now, it is quite clear that each of these three distinct dogs is made up of separate elements, and can not possibly be regarded as being located in a single cell or fiber alone. Dog auditory is made up of the audible consonantal sound D, the audible vowel-sound aŭ or ŏ (unhappily we have no universally recognized phonetic system), and the other audible consonantal sound G hard; in that precise order of sequence and no other. Dog pronounceable is made up of an effort of breath against tongue and teeth, producing the soft dental sound D, followed by an unimpeded vocalized breath, producing the audible vowel-sound aŭ or ŏ, and closed by a stoppage of the tongue against the roof of the mouth, producing the soft palatal G. Finally, dog legible, in print at least, is composed of the separate symbols D and O and G, or d and o and g, or *d* and *o* and *g*. Yet all these distinct and unlike dogs would be unhesitatingly classed by most people under the head of language, and be located by phrenologists, with their clumsy lumping glibness, in the imaginary "bump" thereto assigned, or by more modern physiologists (whose excellent scientific work I should be the last to undervalue) in the particular convolution of the left hemisphere found to be diseased in many cases of "atactic aphasia," or loss of speech.

How infinitely more complex and varied, then, is the idea of dog, for which all these heard, spoken, written, or printed dogs are but so many rough and incomplete symbols! For the idea of dog comprises the head thereof, and the tail, the four legs, the eyes, the mouth, the nose, the neck, the body, the toes, the hair, the bark, the bite, the canine teeth that inflict it, and all the other known and remembered peculiarities of perfect doghood as ideally realizable. If we are to assign peradventure a special tract in the brain to the concept dog, it must be clear at once that that tract will be itself a very large and much subdivided region. For it must include all the separate visible attributes of the dog in general; and also it must contain as sub-species in subordination to it every kind of known dog, not only those already enumerated, but also the Eskimau dog, the Pomeranian, the French poodle, the turnspit, the Australian dingo, the Cuban bloodhound, the Gordon setter, and so forth, through every other form of dog the particular possessor of that individual brain has ever seen, cognized, or heard of. Is it not clear that, on the hypothesis of such definite and distinct localization, dog-tract alone ought to monopolize a region about one sixth as big every way as our whole assignable provision of brain-surface?

Moreover, about this point we seem to be getting ourselves into a sad muddle. For we have next to remember our own private dog, Grip, let us call him, or if you prefer it, Prince or Ponto. Now, I suppose, his name, viewed as a name, will be localized in the language department of our particular brain, and will there be arranged under the general heading of proper names, division dog-names. But there must be some intimate cross-connection between the cell or cells representing the audible and pronounceable name Grip, or the letters G, R, I, P, and the cell or cells which have to do with the idea dog, and also, I imagine, with the name dog: for both the word Grip is intimately connected in my mind with the words "my dog," and the idea Grip is intimately connected in that same humble empirical subjectivity with the idea of dog in general. In fact, I can't think of Grip without thinking at once of his visible appearance, his personal name, and his essential dogginess of name and nature. Grip is to me a symbol, primarily, of some dog or other, and secondarily or more particularly of my dog. But whether Grip and Ponto are arranged and pigeon-holed in cells next door to one another, as being both by name dogs; or whether one is arranged under G, as in a dictionary, and the other under P (just after Pontius, for example, and just before Pontus Euxinus, both of which form distinct component elements of my verbal memory), I can not imagine. At each step in the effort to realize this wooden sort of localization, is it not clear that we are sinking deeper and deeper into a bottomless slough of utter inconceivability?

Once more (and this shall be my last attempt to point out the absurdity of the extreme cell-theory), what are we to make of the case of a man who knows more than one language? Take for example the word *chien*. Here, in one direction, all the associations and connections of idea are exactly the same as in the word *dog*. If I happen to be speaking English I say, "It's a dog"; if I happen to be speaking French, I say, "*C'est un chien*," and in both cases with just about the same idea in my mind. The picture called up by the one word is exactly the same, in most respects, as the picture called up by the other. Yet not precisely. If I write Paris, so, the notion immediately aroused in the reader's mind is that of a white and glaring brand-new city across the Channel where we all go to waste our hard-earned money at periodical intervals. But if in the preceding line I had happened to talk of Priam and Helen, the idea called up by that self-same combination of one capital letter and four small ones would have been a wholly different one, of an idyllic shepherd, as in Tennyson's "Enone," or of a handsome scamp as in (Homer's) "Iliad." If I write "baker," everybody knows I mean the man who supplies hot rolls for breakfast; but if I write "Baker," everybody is aware that I allude to Sir Samuel or to his brother the Pasha. Now, this alternative possibility is even worse in the case of *chien*. For, if I am talking French, the sight of a particular animal which usually calls up to my lips the word "dog," calls up instead the totally different word *chien*. And if the subject in hand is philology, while dog immediately suggests to me the curious practical falling out of our language of the primitive word hund, hound, now only applied to a special class of dogs, and the substitution for it of a Scandinavian and Dutch root not found in Anglo-Saxon, *chien* immediately suggests to me its ultimate derivation from its original *canis*, and the habitual change of *c* before *a* into *ch* in the passage of words into French from Latin. By this time, I think the reader (with his usual acuteness) will begin to perceive into what a hopeless network of cross connections and crooked combinations we have managed to get ourselves in our search after the definitely localizable.

How, then, does the mechanism of the brain really act? I believe the true answer to this question is the one most fully given by M. Ribot and never yet completely accepted by English psychologists. It acts, for the most part, as a whole; or at least, even the simplest idea or mental act of any sort is a complex of processes involving the most enormously varied brain-elements. Instead of dog being located somewhere in one particular cell of the brain, dog is an idea, audible, visible, legible, pronounceable, requiring for different modes of its perception or production the co-operation of an enormous number of separate cells, fibers, and ganglia.

Let us take an illustration from a kindred case. How clumsy and awkward a supposition it would be if we were to imagine there was a muscle of dancing, and a muscle of walking, and a muscle of rowing, and a muscle of cricketing, and a muscle for the special practice of the noble art of lawn-tennis! Dancing is not a single act; it is a complex series of co-ordinated movements, implying for its proper performance the action of almost all the muscles of the body in different proportions, and in relatively fixed amounts and manners. Even a waltz is complicated enough; but when we come to a quadrille or a set of lancers, everybody can see at once that the figure consists of so many steps forward and so many back; of a bow here, and a twirl there; of hands now extended both together, and now held out one at a time in rapid succession; and so forth, throughout all the long and complicated series. A quadrille, in short, is not a name for one act, for a single movement of a single muscle, but for many acts of the whole organism, all arranged in a fixed sequence.

It is just the same with the simplest act of mental perception. Orange, for example, is not the name of a single impression; it is the name of a vast complex of impressions, all or most of which are present to consciousness in the actuality whenever we see an orange, and a great many of which are present in the idea whenever we remember or think of an orange. It is the name of a rather soft, yellow fruit, round in shape, with a thick rind, white inside, and possessing a characteristic taste and odor; a fruit divisible into several angular, juicy segments, with cells inside, and with pips of a recognized size and shape—and so forth, *ad infinitum*. In the act of perceiving an orange we exercise a number of separate nerves of sight, smell, taste, and feeling, and their connected organs in the brain as well. In the act of thinking about or remembering an orange we exercise more faintly a considerable number of these nerves and central organs, though not, of course, all distinctly, or all together; otherwise, our mental picture of an orange would be as vivid and all-embracing as the sight of the actual orange itself.

Now, the name orange calls up more or less definitely the picture of several among these separate qualities. But it doesn't call them all up; indeed, the word in itself may not perhaps call up any of them. For instance, in the phrase, the Prince of Orange, where identical symbols meet the eye, I don't think of the fruit at all; I think, according to circumstances and context, either of William III of blessed memory, or of the eldest son of the present King of the Netherlands, whose memory (in Paris especially) is somewhat more doubtful. An orangeman and an orange-woman are not, as one might innocently imagine, correlative terms. Even without this accidental ambiguity, derived from the name of the town of Orange on the Rhône, the word orange need not necessarily connote anything more than the color by itself; as when we say that Miss Terry's dress was a deep yellow or almost orange. Nay, when we actually mean the fruit in person, not the tree, flower, or color, the picture called up will be different according to the nature of the phrase in which the word occurs. For, if I am talking about ordering dessert, the picture in my mind is that of five yellow fruits, piled up pyramid-wise on a tall center-dish; whereas, if I am talking to a botanical friend, my impression is rather that of a cross-section through a succulent fruit (known technically as a *hesperidium*), and displaying a certain familiar arrangement of cells, dissepiments, placentas, and seeds. In short, the word orange, instead of being a single unity, localizable in a single ganglion, represents a vast complex, of which now these elements are uppermost in consciousness and now those, but which seems to demand for its full realization an immense co-operation of very diverse and numerous brain-organs.

Every thought, even the simplest, involves for its production the united or associated action of a vast mass of separate brain-cells and separate brain-fibers. One thought differs from another dynamically rather than statically. It differs as running differs from dancing—not because different muscles are employed, but because the same muscles are employed in a different manner.

Trains of thought are therefore like a quadrille. One set of exercises is followed by another, which it at once suggests or sets in motion.

Of course, I do not mean to deny that every cell and fiber in the brain has its own particular use and function, any more than I would deny that each particular muscle in the body is intended to pull a particular bone or to move a particular definite organ. But what I do mean is that each such separate function is really elementary or analytical: its object is to assist in forming a conception or idea, not to contain, as it were, a whole conception ready made. Chinese symbols stand each for an entire word, and it takes thousands of them to make up a language; alphabetical letters stand each, not for a word, but for an elementary sound or component of a word, and twenty-six of them do (very badly, it is true) for all the needs of our mother English. Just so, each cell or fiber in the brain does not stand for a particular word or a particular idea, but for some element of sensation or memory or feeling that goes to make up the special word or idea in question. Horse is made up of five letters, or of four phonetic sounds; it is made up also of a certain form and size and color and mode of motion; and when we speak of it all these elements are more or less vaguely present to our consciousness, coalescing into a sort of indefinite picture, and calling up one another more or less symbolically.

This theory at first sight seems to make the explanation of memory far more difficult and abstruse than formerly. For on the old hypothesis (never perhaps fully pushed to its extreme in realizable thought by any sensible person) it seemed easy enough to say that every act of perception and every fact learned was the establishment of a line of communication between two or more distinct cells or ganglia in the brain, and that the communication, once fairly established, persisted pretty constantly ever afterward. I am told "Shakespeare was born at Stratford-on-Avon"; and forthwith, cell Shakespeare (or Shakspere, or Shakspear, etc.) has a line run from it to cell birth and cell Stratford-on-Avon (a pretty complex one indeed, this last), which line remains from that day forward permeable to any similar exercise of nervous energy. This method is undeniably simple, neat, and effective. But, setting aside the difficulty of realizing that any one tract of the brain can possibly hold our whole vast mental picture of Shakespeare or of Stratford-on-Avon (especially if we have ever read the one or visited the other), there is the grotesque difficulty of the innumerable lines and cross-connections of association. A central telephone station would be the merest child's-play to it. For even so simple a word and idea as gooseberry is capable of arousing an infinite number of ideas and emotions. It may lead us at once to the old garden in the home of our childhood, or to the gooseberry-fool we ate yesterday; it may suggest the notion of playing gooseberry, or the big gooseberry of the newspaper paragraph; it may lead to etymological dissertation on its derivation from gooseberry, allied to north country grosers and French *groseille*, or it may summon up visions of bad champagne, incidentally leading to "The Vicar of Wakefield," and the famous wine manufactured only by Mrs. Primrose. In fact, I have no hesitation at all in expressing my private opinion that, if the chart of the brain were at all like what most people imagine it to be, the associations of the word gooseberry alone would suffice to give good and solid employment to every fiber, cell, and convolution it anywhere possesses.

On the other hand, if we regard the brain as mainly dynamical, as an organism capable of very varied combinations of action, we can easily see, not only how memory becomes possible, but also how such infinite variations of association are rendered conceivable. For if every thought or perception is, as it were, an organized tremor in a vast group of diverse nerve-elements, often indeed in almost all together, it is simple enough to understand how these tremors may fall into regular rhythms, may excite one another in regular successions, may get habitual, just as the steps do in dancing, or the movements of the hand in writing a familiar and well-remembered formula—for example, in signing one's name. Here, in this immense and minutely organized workshop, we have a constant succession of motions in wheels and gearing, so arranged that each motion may be communicated in a thousand directions, and what is apparently a single impetus may call up the most diverse and extraordinary results. But, in reality, the impetus is not single: for, when we are thinking of horse in one way, we have a certain fixed form of movement called up; while, if we are thinking of it in another way, the form called up, though analogous in many respects, is far indeed from being identical. When I write "nice," you think of something or other vaguely pleasant; but, when I write "Nice," the very pronunciation is altered into something very like "niece," and the picture that rises before your mind is the very definite one of the Promenade des Anglais, with its long line of white villas and stunted palm-trees, bounded by the blue horizon of the Mediterranean and the beautiful slopes of the coast toward Villefranche. It is just the same with the apples and the oranges. The elements of the picture vary incessantly; and while one combination now suggests one association, another combination another time suggests a second. The elements join together in an infinite variety of ways, and so a finite number of cells and fibers enable us to build up all the wealth of thought, just as twenty-six tiny symbols allow us to express all the wonderful conceptions of Milton and all the beautiful ideas of Shelley. There are only fifty-two cards in a pack, it is true, but no two games of whist ever yet played, in all probability, were absolutely identical.

To sum it all up: it is the brain as a whole that thinks, and feels, and desires, and imagines, just as it is the body as a whole that walks, and swims, and digs, and dances. To locate, say, the faculty of language in a particular convolution of a particular hemisphere is almost as absurd, it seems to me, as to locate, say, the faculty of writing in the last joint of the right forefinger. Convolution and forefinger may be absolutely essential or indispensable for the proper performance of speech or writing; but to say that is not to say that the function in question is there localized. The brain as a whole is the organ of mind, but there is no organ for the word Canonbury or for the proper perception of a Mrs. Pollock geranium.—*Gentleman's Magazine.*

HEALTH AND SEX IN HIGHER EDUCATION.

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IT may not generally be known that the alumnæ of the more important centers of female higher education in this country have an organized intercollegiate association for the promotion of woman's education and the study of questions regarding her training. This association has justified its existence, if justification were necessary, by the inquiries which it has made regarding the health of those women who have pursued college courses. The importance of the results thus obtained has led to their incorporation in the "Current Report of the Massachusetts Labor Bureau." For the first time the discussion is taken from the *a priori* realm of theory on the one hand, and the hap-hazard estimate of physician and college instructor on the other. The returns have the value of all good statistics: they not only enable us to come to some conclusion upon the main point discussed, but they are so full and varied that they suggest and mark the way toward the discussion of a large number of other hardly less important questions. The figures, in short, call up as many problems as they settle, thus fulfilling the first requisite of fruitful research.

Pursuing this line, we shall first state the general character of the investigation followed and conclusions reached; and, secondly, isolate a few special problems for more detailed though brief treatment. The result may be summed up in the words of the report, as follows: "The female graduates of our colleges and universities do not seem to show, as the result of their college studies and duties, any marked difference in general health from the average health likely to be reported by an equal number of women engaged in other kinds of work. It is true that there has been, and it was to be expected that there would be, a certain deterioration in health on the part of some of the graduates. On the other hand, an almost identical improvement in health for a like number was reported, showing very plainly that we must look elsewhere for the causes of the greater part of this decline in health during college-life. If we attempt to trace the cause, we find that this deterioration is largely due, not to the requirements of college-life particularly, but to predisposing causes natural to the graduates themselves, born in them, as it were, and for which college-life or study should not be made responsible."

Through some oversight the statement is made that the returns include statistics from every higher institution in the United States open to women; while, as a matter of fact, it includes a not comparatively large number. The institutions represented, however, are typical. The data are contained in the following table:

Name of College.	Sex distinction.	Date of organization.	Total number of female graduates to 1882 inclusive.	Number of returns received.	Percentage of returns received.
Boston University...........	Co-educational.	1873	47	29	61·70
Cornell University	Co-educational.	1868	80	36	45·00
Kansas, University of.......	Co-educational.	1866	36	20	55·56
Mass. Institute of Technology.	Co-educational.	1865	5	3	60·00
Michigan, University of......	Co-educational.	1841	87	46	52·87
Oberlin College.............	Co-educational.	1833	104	39	37·50
Smith College..............	Females only.	1875	90	43	47·78
Syracuse University.........	Co-educational.	1871	65	17	26·15
Vassar College.............	Females only.	1865	540	344	63·70
Wellesley College...........	Females only.	1875	110	71	64·55
Wesleyan University........	Co-educational.	1831	15	6	40·00
Wisconsin, University of.....	Co-educational.	1849	111	51	45·95
All colleges...........		....	1,290	705	54·65

For purposes of comparison, the value of the statistics is vitiated by the fact that the date of the admission of women is not given, and this, in the cases of the co-educational college, does not agree with the date of organization. Other facts, which we omit, go to show that the average date of admission, Oberlin being excluded, may be safely put at about 1870.

The questions involved in the inquiry were exceedingly comprehensive, and may conveniently be considered under three heads, of which the first takes up the *conditions of childhood*, comprehending date of birth, nationality of parents, surroundings in childhood, amount of exercise received between the ages of eight and fourteen, the age at which study began, the age at entering college, and the age at graduation. The second section relates to *individual health*, and comprehends physical condition; nervousness; the age at beginning of the menstrual period; the conditions attending the menstrual periods; the number of graduates reporting disorders; the number of disorders; the number reporting each disorder, and the causes of disorders.

From the broad data thus obtained, the third section, a series of comparison tables, is gathered. Of these one of the most important compares the present health of graduates with the age at beginning study, the age at entering college, the time entering college after the menstrual period commenced, the amount of out-of-door exercise, and hereditary conditions. Another compares the health during college-life with the age at entering, the amount of study performed, the amount of worry about private and college affairs, etc. The first set is thus seen to be occupied with giving a picture of health through life, while the second endeavors to ascertain the changes introduced by college-life, and their causes.

The general features of the tables may be stated as follows:

Colleges.	Average Age.				
	At beginning study.	At beginning of menstrual period.	At entering college.	At graduating from college.	At present time.
Boston	5·25	13·89	19·61	23·36	26·72
Cornell	5·31	13·94	19·43	23·09	26·66
Kansas	5·25	13·65	16 32	21·75	26·35
Mass. Inst. of Tech.	6·00	13·67	21·00	24·00	25·67
Michigan	5·38	13·49	19·26	23·22	29·00
Oberlin	4·95	13·58	19·69	24·10	41·74
Smith	5·64	13·48	19·19	22·69	25·02
Syracuse	5·69	13·76	19·65	23·47	28·24
Vassar	5·91	13·61	17 81	21·96	28·95
Wellesley	5·51	13·56	18·34	22·24	24·90
Wesleyan	4·50	13·60	20·00	24·00	29·00
Wisconsin	5·49	13·57	17·98	21·69	27·24
All colleges	5·64	13·62	18·35	22·39	28·58

The influence upon health may be summed up very generally as follows: The maximum per cent of good health, 78·1, is reported at the time of entering college; during college-life this falls off to 74·9 per cent, to be followed by a rise to 77·9 per cent since graduation; fair health shows a gain from 2 to 8 per cent during college-life, followed by a decrease to 5 per cent since that time; while there was an actual decrease of 2 per cent during college-life of those having poor health, the figures being respectively 19·8 and 17·3 per cent, no appreciable change being shown for the years since graduation.

From the comparison tables it is further shown that 138, or 19·6 per cent, report a deterioration in health during college-life; 418, 59·3 per cent, no change; 149, 21·1 per cent, show an improvement. This result may be compared with the returns of the inquiries instituted by the Massachusetts Board among the working-girls of Boston, as follows: Of the 705 female college graduates, 138, or 19·58 per cent, show a deterioration in health during college-life, and of the 1,032 working-girls, 166, or 16·09 per cent, show a deterioration in health, during working-time, these figures indicating a greater loss of health, of 3·49 per cent, reported by the college graduates. For the 166 working-girls, whose health deteriorated, four had quite good health at the time of the investigation, 128 were in fair health, and 34 in poor health. Of the 138 college graduates whose health deteriorated, however, 42 report a decline in health from excellent to good, or a slight change only. Making allowances for this, there is a greater loss of health of 2·47 per cent reported by the working-girls of Boston.

Of the 705 reporting, 417, or 59 per cent, mention some disorder, and the total number of disorders reported is 865. The returns regarding the causation of disease, while not technical nor detailed enough for scientific value, are suggestive.

Of the 417 reporting disorders, 276 give the cause or causes of disorders, and for 141 no cause is reported. One hundred and thirty-five consider constitutional weakness to have been the cause of disorder; 81, bad sanitary conditions; 81, intellectual overwork; 73, emotional strain; and 47, physical accidents.

The average amount of exercise reported, considering the aversion of American women, especially the educated, to bodily exertion, may be considered fairly encouraging. The average distance walked per day is given at 2·5 miles, and the time spent in other exercise as 1·2 hour. Returns regarding the amount of college-study done by college-women would gain in interest if they could be put side by side with corresponding returns from their male companions: 4, or 0·57 per cent, studied but little while at college; 438, or 62·13 per cent, studied moderately; 64, or 9·08 per cent, between moderately and severely, and 199, or 28·22 per cent, severely.

Either the lazy students failed to report, or college-women have much to learn from the average male undergraduate about the science of laziness. The lonely four, who have the courage of their disposition, all come from one college, which it would be ungallant to specify. Statistics concerning worry show that the art of taking things easy is not yet mastered by our ambitious young women: 172, or 24·40 per cent, worried over their studies; 89, or 12·62 per cent, over personal affairs; 131, or 18·58 per cent, worried over both studies and affairs; while 313, or 44·40 per cent, worried over neither studies nor affairs.

These returns for the most part tell their own tale and point their own moral. They certainly bear out the conclusion drawn regarding the uninjurious effect of collegiate study. Their great defect is in their failure to show more definitely the conditions and surroundings of college-life. The physical, social, and moral environment should be carefully studied. It has long been a commonplace of vital science that intellectual pursuits for men *per se* are healthy. The question which needs solution is, What conditions prevent their being equally healthy for women, the exact part played by each factor, and how far it is removable? What parents as well as professional educators and college administrators wish to know is, what colleges have gymnasiums, and whether the exercise is compulsory; how many institutions have matrons, and how far their influence extends; how many have resident physicians. Do the young women live herded in halls, sheltered in cottages, or at home and at boarding-houses as convenience dictates? The number of hours of sleep taken should be exactly stated. The number of hours of study should be given, instead of the vague terms "moderate," etc. Instead of indefinite inquiries as to whether the student went into society much or little, exact inquiries into the various modes of spending the hours of social recreation should be made. These and many similar points, which would suggest themselves at once, may be considered trivial; but, if we accept the general conclusion of the report that the pursuit of collegiate education is not in itself harmful, the importance of studying the entire environment, physical and social, of the young student at once appears. Here, in fact, the problem of her education centers.

Turning from the general conclusion to the consideration of certain specific problems, we educe the following data for discussion :

By all odds the most important fact regarding the higher education of woman is, that we are educating wives and mothers. Few probably will regret this, but those few must still admit the fact in a society constituted like ours. This, then, is the heart of the situation, and, in view of it, the following statistics are suggestive :

Omitting Oberlin College, for reasons already given, 26 per cent of the graduates who report are married, the other 74 per cent single. The average number of years since graduation is, however, over six, and average age over twenty-seven. Of the married, 37 per cent are without children, although the average number of years married is 6·2. The one hundred and nine having children report 205. Of these, 12 per cent have died, and, of these deaths, 25 per cent are due to causes connected with bearing. If we include all married couples, there is but 1·2 child to every five years of married life ; and, even if we exclude those not having borne any, there are, among the remainder, two children to seven years of married life. We leave these figures, as the others, to speak for themselves.

That three hundred report their post-graduate occupations as teaching, and that one hundred and sixteen are following a professional life, shows a fact too easily lost sight of. Collegiate courses for woman have not solved the problem of her *education*, but, at most, of her technical training. It can hardly be thought desirable that 60 per cent of all the young women of our country, who ought to have collegiate training, should have it only as a preparation for one of the professions or for teaching. The question of women's education, in any worthy sense of the term education, has yet to be faced. The remarkable fact that the courses for female education, as well in purely female institutions as in co-educational, run parallel with and are modeled after the curriculum of male colleges, is to be accounted for only on the ground that upon the whole their training is designed for those who have to compete with men in the professional walks of life.

If we confine ourselves to the health of women, we shall find that the figures hardly justify us in assuming a purely optimistic attitude. The following figures speak for themselves : Of those who entered college one or two years after the commencement of the menstrual period, 20·5 per cent had poor health during college-life ; of those who entered three to five years after, but 17·7 per cent ; and more than five years, 15·4 per cent. If we compare the ages at entering college with the relative improvement or deterioration in health, we reach the same result. Of those who entered college at sixteen years or under, 28 per cent fell off in health, while 17 per cent gained. The figures for those of twenty and over show an almost exact reversal of these percentages, being 18 per cent loss and 28·5 per cent gain. The problem of age is thus seen to be an exceedingly important one.

The fact that, of the disorders reported, 7 per cent are brain troubles, 26 per cent of reproductive organs, and 33 per cent nervousness (also 15 per cent of neuralgia), shows that the problem of health has yet to find its adequate solution. The following percentages tell the same story: During the period of development, 53 per cent were troubled during the menstrual period (with simple irregularities, uterine or reflex pain, one or all). During college-life the per cent was 66; since graduation, 64. If we isolate simple irregularities, the result is more significant still; for these show a constant decrease, while the organic troubles show as marked an increase, the figures being, respectively, for irregularities, 16 per cent, 9 per cent, 7 per cent; for uterine and reflex pain, 24 per cent, 36 per cent, 36 per cent, for the three periods of development, college, and graduate life. Such percentages show along what line effort should be directed.

Leaving this question, we turn to the phenomena of college-life, so far as regards exercise, study, and worry, in their effects upon health. The tables here cease to have reference, in their bearing, to women alone, and point a moral for all educators to heed. The importance of exercise is shown by the fact that those reporting over two hours per day return 84 per cent in good or fair health, while those below two hours can show but 75 per cent. It is hardly an exaggeration to say that, upon the whole, the tables show that worry is the most potent of all predisposing causes of disease. Those who had no worries of account report 92 per cent in fair or good health; those worrying over both personal affairs and studies state that but 68 per cent of their number were in the same condition. Worry over personal matters seems to be more harmful to health than overstudies, 75 and 80 per cent being the proportion of good health respectively. This showing goes far in substantiating the opinion of those who hold that study *per se* is never a cause of failure of health. However, of those who studied severely, 21 per cent report poor health, against 15 per cent of those studying moderately. Again, of the latter, 54 per cent report disorders as against 70 per cent of those who studied more; the figures for nervousness also are 15 and 26 per cent respectively. It is fair to suppose, however, that the largest per cent of those worrying over their studies was found among those studying severely.

In the tables, the distinction is made between those reporting from female colleges only and those of the co-educational. It is an easy matter, however, to separate them, which I have done, with the following results: Of the whole number (705), 458 are from female colleges; 247 co-educational. For graduate life, the figures for health are exactly the same for both: 83 per cent in good health, and 17 per cent in poor. During college-life 16 per cent of the co-educationalists report poor health, as against 18 per cent of those from female colleges; but this is more than accounted for by the fact that 22 per cent of the latter were in poor health *before* entering, showing a real gain during college-life of 4 per cent in average health, while the reports of co-educational colleges show a gain of but one per cent. It must be noticed, however, that the female colleges show a falling off of 4·8 per cent from good to fair health, while the co-educational show a similar loss of but 0·3 per cent. The average number of disorders reported is much the same for each class: 1·19 for graduates of female colleges; 1·24 for the other class. The figures as given show that either more care is taken of personal health in the female colleges than in the co-educational, or that more supervision is exercised; for 55 per cent of the former report abstinence from study and exercise during the menstrual period, and only 25 per cent of the latter. The figures for disorders show no corresponding gain, however, the advantage here being on the side of the co-educational institutions, as the latter report 33 per cent of disorders of brain, nerves, and reproductive organs, against 41 per cent in the female colleges. The figures for worry are about the same in each class: 33 per cent report severe study in the co-educational colleges, as against 26 per cent in the other; the advantage in exercise is, however, somewhat on the side of the co-educational college. The figures in the causation of disorders show the same percentages arising from intellectual overwork and physical accident. The female colleges, however, report proportionately over one third more breaking down from emotional strain, while the co-educational colleges balance the account with one fourth more failing in health by reason of bad sanitary conditions.

Of the life since graduation, not much can be said: 23 per cent of the graduates of the female colleges have married; 28 per cent of the co-educational, the average age of each being the same. Competition with men seems to have led a less number of graduates of co-educational colleges to enter the professions; at all events they report but 12 per cent in the professions, while the female colleges report 21 per cent. A somewhat larger number follow teaching, however, the figures here being 48 per cent and 42 per cent respectively.

It would certainly be too much to say from these figures that the personal care and advice from others given in female colleges are greater, while the social surroundings in the co-educational colleges are healthier, because perhaps more natural; but they suggest the advisability of questions directed to these points. The female colleges seem to have the advantage in purely sanitary conditions (except amount of exercise), as witnessed by the smaller percentage reporting bad sanitation as cause of disease; by the advantage of more than two to one of abstinence from study at critical periods, and in moderation of study; while the advantage of health remains on the side of the co-educational during college-life. That the balance shifts after graduation would point in the line of the generalization already suggested; as with the cessation of college-life would cease the abnormal cloistering of the young women, while bad sanitary conditions would show comparatively permanent results. That proportionately one third more in the female colleges report emotional strain as cause of disorders, other causes showing much the same average, point in the same direction. At any rate, it is worth inquiry whether it is not possible to unite the presumed advantage of the female colleges in wise advice and proper attention to health with the freer and more natural social relations of the co-educational institutions.

It is hoped that enough has been said to show the importance of the investigations already made, and to justify the supposition that further more detailed and extended inquiries would increase their value. No educator at all acquainted with the present status of affairs will carp at the results already reached, nor will he find much but cause for thankfulness upon a survey of the field; but his outlook must be directed toward the future, not the past. Nothing could well be more fatal to the cause of woman's education than to suppose that the question is already settled. The commencement has indeed been made, but only the commencement. Mere multiplication of institutions and influences of the existing type, however valuable, as affording opportunities to individual young women, will do little toward determining the larger aspects of the case. Were the number of purely women's colleges largely increased, and were all the important boys' colleges to open their doors to girls, only the necessary *basis* for the solution of the problem would be obtained.

Such inquiries as we have briefly summarized can do more than aught else to furnish necessary data for a wise and comparatively permanent solution. Discussion on partisan lines is absolutely valueless, and *a priori* discussion will effect nothing. The unbiased study by educational experts of the fruits actually borne by experience is invaluable, and the generalizations based upon such data will show the lines upon which reform must work itself out. This is not the place to formulate the exact nature of such inquiries, but they should cover at least three heads:

I. Health.—The present report offers a valuable model to follow. More attention should be given to the social and moral environment of college-life, however, even in this point; and the discussion should more definitely concern the specifically female functions.

II. Life since Graduation.—The brief notes respecting marriages and occupations in the report discussed are all we have on this head. It should be treated with a view to determining as accurately as may be the position which the college-educated woman holds and desires to hold in the body social and politic. When we recollect the difficulty in adjusting young men's collegiate education to their life after graduation, in spite of the accumulation of infinite experience, the value of such a report in determining the lines which woman's college education should follow, in the dearth of information upon the topic, is at once seen.

III. SPECIFIC DATA FOR FUTURE MOVEMENTS.—These should be based upon confidential revelations made by the graduates themselves, together with the testimony of college officers and physicians. It should not be limited narrowly. They should go far beyond the question of bodily health. The statement of what each had found the greatest aid and the greatest hindrance in her collegiate training would be of much value. Experience alone can decide the exact form which these inquiries should take, but their importance can hardly be overestimated in the moral and social aspects of the case.

Education must follow the example of the special sciences. *It must organize.* There is organization, and to spare, in the schools themselves; what we want is organized recognition of the problems of education; organized study for the discovery of methods of solution; organized application of these methods in the details of school-life. Co-operation in research and application is the key to the problem.

PROEM TO GENESIS:

A REPLY TO PROFESSOR HUXLEY.

By WILLIAM E. GLADSTONE.

*VOUS avez une manière si aimable d'annoncer les plus mauvaises nouvelles, qu'elles perdent par là de leurs désagrémens.** So wrote, *de haut en bas* (from above down), the Duchess of York to Beau Brummell, sixty or seventy years back; † and so write I, *de bas en haut* (from below up), to the two very eminent champions who have in the "Nineteenth Century" of December entered appearances on behalf of Dr. Réville's *Prolégomènes*, with a decisiveness of tone, at all events, which admits of no mistake: Professor Huxley and Professor Max Müller. My first duty is to acknowledge in both cases the abundant courtesy and indulgence with which I am personally treated. And my first thought is that, where even disagreement is made in a manner pleasant, it will be a duty to search and see if there be any points of agreement or approximation, which will be more pleasant still. This indulgence and courtesy deserves in the case of Professor Huxley a special warmth of acknowledgment, because, while thus more than liberal to the individual, he has for the class of Reconcilers, in which he places me, an unconcealed and un-

* You have so gentle a way of telling the worst news that it thereby loses its unpleasantness.

† "Life," by Jesse. Revised edition, i. 260.

measured scorn. These are they who impose upon man a burden of false science *in the name of religion*, who dictate as a Divine command "an implicit belief in the cosmogony of Genesis;" and who "stir unwisdom and fanaticism to their depths."* Judgments so severe should surely be supported by citation or other evidence, for which I look in vain. To some they might suggest the idea that Passion may sometimes unawares intrude even within the precincts of the temple of Science. But I admit that a great master of his art may well be provoked, when he finds his materials tumbled about by incapable hands, and may mistake for irreverence what is only want of skill.

While acknowledging the great courtesy with which Professor Huxley treats his antagonist individually, and while simply listening to his denunciations of the Reconcilers as one listens to distant thunders, with a sort of sense that after all they will do no great harm, I must presume to animadvert with considerable freedom upon his method; upon the sweeping character of his advocacy; upon his perceptible exaggeration of points in controversy; upon his mode of dealing with authorities; and upon the curious fallacy of substitution by which he enables himself to found the widest proscriptions of the claim of the Book of Genesis to contain a Divine record upon a reasoned impeachment of its scientific accuracy in, as I shall show, a single particular.

As to the first of these topics, nothing can be more equitable than Professor Huxley's intention to intervene as a "science proctor" in that part of the debate raised by M. Réville, "to which he proposes to restrict his observations" (*P. S. M.* p. 449). This is the part on which he proposes in his first page to report as a student—and every reader will inwardly add, as one of the most eminent among all students—of natural science. Now this is not the cosmogonical part of the account in Genesis. On Genesis i. 1–19, containing the cosmogony, he does not report as an expert, but refers us (p. 859) to "those who are specially conversant with the sciences involved;" adding his opinion about their opinion. Yet in his second page, without making any reference to this broad distinction, he at once forgets the just limitation of his first, and our "proctor for science" pronounces on M. Réville's estimate, not of the fourfold succession in the stratification of the earth, but of "the account of the Creation given in the Book of Genesis," that its terms are as "respectful as in his judgment they are just" (*ibid.*). Thus the proctorship for science, justly assumed for matters within his province as a student, is rather hastily extended to matters which he himself declares to be beyond it. In truth it will appear, that as there are many roads to heaven with one ending, so, provided only a man arrives at the conclusion that the great Proem of Genesis lends no support to the argument for Revela-

* "Popular Science Monthly," February, 1886, pp. 459, 460.

tion, it does not much matter how he gets there. For in this "just" account of the Creation I have shown that M. Réville supports his accusation of scientific error by three particulars (*N. C.* p. 689): that in the first he contradicts the judgment of scholars on the sense of the original; in the second he both misquotes (by inadvertence) the terms of the text, and overlooks the distinction made so palpable (if not earlier) half a century ago, by the work of Dr. Buckland,* between *bara* and *asa;* while the third proceeds on the assumption that there could be no light to produce vegetation, except light derived from a visible sun. These three charges constitute the head and front of M. Réville's indictment against the cosmogony; and the fatal flaws in them, without any notice or defense, are now all taken under the mantle of our science proctor, who returns to the charge at the close of his article (p. 459), and again dismisses with comprehensive honor as "wise and moderate" what he had ushered in as reverent and just. So much for the sweeping, undiscriminating character of an advocacy which, in a scientific writer, we might perhaps have expected to be carefully limited and defined.

I take next the exaggeration which appears to me to mark unhappily Professor Huxley's *method.* Under this head I include all needless multiplication of points of controversy, whether in the form of overstating differences, or understating agreements, with an adversary.

As I have lived for more than half a century in an atmosphere of contention, my stock of controversial fire has perhaps become abnormally low; while Professor Huxley, who has been inhabiting the Elysian regions of science, the *edita doctrinâ sapientûm templa serena,*† may be enjoying all the freshness of an unjaded appetite. Certainly one of the lessons life has taught me is, that where there is known to be a common object, the pursuit of truth, there should also be a studious desire to interpret the adversary in the best sense his words will fairly bear; to avoid whatever widens the breach; and to make the most of whatever tends to narrow it. These I hold to be part of the laws of knightly tournament.

I do not, therefore, fully understand why Professor Huxley makes it a matter of objection to me that, in rebuking a writer who had treated evolution wholesale as a novelty in the world, I cited a few old instances of moral and historical evolution only, and did not extend my front by examining Indian sages and the founders of Greek philosophy (*P. S. M.* p. 454). Nor why, when I have spoken of physical evolution as of a thing to me most acceptable, but not yet in its rigor (to my knowledge) proved (*N. C.* p. 705), we have only the rather niggardly acknowledgment that I have made "the most oblique ad-

* "Bridgewater Treatise," vol. i. pp. 19–28. Chap. i.: "Consistency of Geological Discoveries with Sacred History."

† Lucr. ii. 8. (Serene heights raised by the learning of the wise.)

missions of a possible value" (*P. S. M.* p. 454). Thus it is when agreement is threatened, but far otherwise when differences are to be blazoned. When I have spoken of the succession of orders in the most general terms only, this is declared a sharply divided succession in which the last species of one can not overlap the first species of another (p. 457). When I have pleaded on simple grounds of reasoning for the supposition of a substantial correspondence between Genesis i. and science (*N. C.* p. 696), have waived all question of a verbal inspiration, all question whether the whole of the statements can now be made good (*N. C.* p. 694), I am treated as one of those who impose "in the name of religion" as a divine requisition "an implicit belief in the accuracy of the cosmogony of Genesis," and who deserve to have their heads broken in consequence (*P. S. M.* p. 460).

I have urged nothing "in the name of religion." I have sought to adduce probable evidence that a guidance more than human lies within the great Proem of the Book of Genesis (*N. C.* p. 694), just as I might adduce probable evidence to show that Francis did or did not write Junius, that William the Third was or was not responsible for the massacre of Glencoe; I have expressly excepted detail (p. 696), and have stated (*N. C.* p. 687) that in my inquiry "the authority of Scripture can not be alleged in proof of a primitive revelation" (*N. C.* p. 687). I object to all these exaggerations of charge, as savoring of the spirit of the Inquisition, and as restraints on literary freedom.

My next observation as to the Professor's method refers to his treatment of authorities.

In one passage (*P. S. M.* p. 450) Mr. Huxley expresses his regret that I have not named my authority for the statement made concerning the fourfold succession, in order that he might have transferred his attentions from myself to a new delinquent. Now, published works are (as I may show) a fair subject for reference. But as to pointing out any person who might have favored me with his views in private correspondence, I own that I should have some scruple in handing him over to be pilloried as a Reconciler, and to be pelted with charges of unwisdom and fanaticism, which I myself, from long use, am perfectly content to bear.

I did refer to three great and famous names: those of Cuvier, Sir John Herschel, and Whewell (*N. C.* p. 697). Mr. Huxley speaks of me as having quoted them in support of my case on the fourfold succession; and at the same time notices that I admitted Cuvier not to be a recent authority, which in geology proper is, I believe, nearly equivalent to saying he is, for particulars, no authority at all. This recital is singularly inaccurate. I cited them (*N. C.* p. 697), not with reference to the fourfold succession, but generally for "the general accordance of the Mosaic cosmogony with the results of modern inquiry" (*ibid.*), and particularly in connection with the nebular hypothesis. It is the cosmogony (Gen. i. 1–19), not the fourfold succession, which was the sole object of Réville's attack, and the main object of my defense; and which is the largest portion of the whole subject. Will Mr. Huxley venture to say that Cuvier is an unavailable authority, or that Herschel and Whewell are other than great and venerable names, with reference to the cosmogony? Yet he has quietly set them aside without notice; and they with many more are inclusively bespattered with the charges, which he has launched against the pestilent tribe of Reconcilers.

My fourth and last observation on the "method" of Professor Huxley is that, after discussing a part, and that not the most considerable part, of the Proem of Genesis, he has broadly pronounced upon the whole. This is a mode of reasoning which logic rejects, and which I presume to savor more of license than of science. The fourfold succession is condemned with argument; the cosmogony is thrown into the bargain. True, Mr. Huxley refers in a single sentence to three detached points of it partially touched in my observations (p. 453). But all my argument, the chief argument of my paper, leads up to the nebular or rotatory hypothesis (*N. C.* 689–94 and 697–8). This hypothesis, with the authorities cited—of whom one is the author of "Vestiges of the Creation"—is inclusively condemned, and without a word vouchsafed to it.

I shall presently express my gratitude for the scientific part of Mr. Huxley's paper. But there are two sides to the question. The whole matter at issue is, 1, a comparison between the probable meaning of the Proem to Genesis and the results of cosmological and geological science; 2, the question whether this comparison favors or does not favor the belief that an element of divine knowledge—knowledge which was not accessible to the simple action of the human faculties—is conveyed to us in this Proem. It is not enough to be accurate in one term of a comparison, unless we are accurate in both. A master of English may speak the vilest and most blundering French. I do not think Mr. Huxley has even endeavored to understand what is the idea, what is the intention, which his opponent ascribes to the Mosaic writer; or what is the conception which his opponent forms of the weighty word Revelation. He holds the writer responsible for scientific precision: I look for nothing of the kind, but assign to him a statement general, which admits exceptions; popular, which aims mainly at producing moral impressions; summary, which can not but be open to more or less of criticism in detail. He thinks it is a lecture. I think it is a sermon. He describes living creatures by structure. The Mosaic writer describes them by *habitat*. Both I suppose are right. I suppose that description by *habitat* would be unavailing for the purposes of science. I feel sure that description by structure, such as the geologists supply, would have been unavailing for the purpose of summary teaching with religious aim. Of Revelation I will speak by-and-by.

In order to institute with profit the comparison, now in view, the very first thing necessary is to determine, so far as the subject-matter allows, what it was that the Pentateuchal or Mosaic writer designed to convey to the minds of those for whom he wrote. The case is, in more ways than one, I conceive, the direct reverse of that which the Professor has alleged. It is not bringing Science to be tried at the bar of Religion. It is bringing Religion, so far as it is represented by this part of the Holy Scriptures, to be tried at the bar of Science. The indictment against the Pentateuchal writer is, that he has written what is scientifically untrue. We have to find then in the first place what it is that he has written, according to the text, not an inerrable text, as it now stands before us.

First, I assume there is no dispute that in Genesis i. 20–27 he has represented a fourfold sequence or succession of living organisms. Aware of my own inability to define in any tolerable manner the classes of these organisms, I resorted to the general phrases—water-population, air-population, land-population. The immediate purpose of these phrases was not to correspond with the classifications of Science, but to bring together in brief and convenient form the larger and more varied modes of expression used in verses 20, 21, 24, 25 of the Chapter.

I think, however, I have been to blame for having brought into a contact with science, which was not sufficiently defined, terms that have no scientific meaning: water-population, air-population, and (twofold) land-population. I shall now discard them and shall substitute others, which have the double advantage of being used by geologists, and perhaps of expressing better than my phrases what was in the mind of the Mosaic writer. These are the words—1, fishes; 2, birds; 3, mammals;* 4, man. By all, I think, it will be felt that the first object is to know what the Pentateuchal writer means. The relation of his meaning to science is essential, but, in orderly argumentation, subsequent. The matter now before us is a matter of reasonable and probable interpretation. What is the proper key to this hermeneutic work? In my opinion it is to be found in a just estimate of the purpose with which the author wrote, and with which the Book of Genesis was, in this part of it, either composed or compiled.

If this be the true point of departure, it opens up a question of extreme interest, at which I have but faintly glanced in my paper, and which is nowhere touched in the reply to me. What proper place has such a composition as the first Chapter of Genesis in such a work as the Scriptures of the Old Testament? They are indisputably written with a religious aim; and their subject-matter is religious. We may describe this aim in various ways. For the present purpose, suffice it to say they are conversant with belief in God, with inculcation of du-

* I wish to be understood as speaking here of the higher or ordinary mammals, which alone I assume to have been probably known to the Mosaic writer.

ties founded on that belief, with history and prophecy obviously having it for their central point. But this Chapter, at the least down to verse 25, and perhaps throughout, stands on a different ground. In concise and rapid outline, it traverses a vast region of physics. It is easy to understand Saint Paul when he speaks of the world as bearing witness to God.* What he said was capable of being verified or tested by the common experimental knowledge, of all who heard him. Of it, of our Saviour's mention of the lilies—and may it not be said generally of the references in Scripture to natural knowledge?—they are at once accounted for by the positions in which they stand. But this first Chapter of Genesis professes to set out in its own way a large and comprehensive scheme of physical facts: the transition from chaos to kosmos, from the inanimate to life, from life in its lower orders to man. Being knowledge of an order anterior to the creation of Adamic man, it was beyond verification, as being beyond experience. As a physical exposition in miniature, it stands alone in the Sacred Record. And, as this singular composition is solitary in the Bible, so it seems to be hardly less solitary in the sacred books of the world. "The only important resemblance of any ancient cosmogony with the Scriptural account, is to be found in the Persian or Zoroastrian:" This Bishop Browne † proceeds to account for on the following among other grounds: that Zoroaster was probably brought into contact with the Hebrews, and even perhaps with the prophet Daniel; a supposition which supplies the groundwork of a recent and remarkable romance, not proceeding from a Christian school.‡ Again, the Proem does not carry any Egyptian marks. In the twenty-seven thousand lines of Homer, archaic as they are and ever turning to the past, there is, I think, only one # which belongs to physiology. The beautiful sketch of a cosmogony by Ovid ‖ seems in considerable degree to follow the Mosaic outline; but it was composed at a time when the treasure of the Hebrew records had been for two centuries imparted, through the Septuagint, to the Aryan nations.

Professor Huxley, if I understand him rightly (*P. S. M.* pp. 451–2), considers the Mosaic writer, not perhaps as having intended to embrace the whole truth of science in the province of geology, but, at least as liable to be convicted of scientific worthlessness if his language will not stand the test of this construction. Thus the "water-population" is to include "the innumerable hosts of marine invertebrated animals." It seems to me that these discoveries, taken as a whole, and also taken in all their parts and particulars, do not afford a proper, I mean a rational, standard for the interpretation of the Mosaic writer; that the recent discovery of the Silurian scorpion, a highly organized animal (p. 458), is of little moment either way to the ques-

* Acts xiv. 17; Romans i. 20.

† Note on Gen. i. 5.

‡ "Zoroaster." By F. M. Crawford. Macmillan, 1885.

\# *Il.* vii. 99.

‖ Ovid, "Metam." i. 1-38.

tion now before us;* that it is not an account of the extinct species which we should consider the Mosaic writer as intending to convey; that while his words are capable of covering them, as the *oikoumenè* of the New Testament covers the red and yellow man, the rules of rational construction recommend and require our assigning to them a more limited meaning, which I will presently describe.

Another material point in Professor Huxley's interpretation appears to me to lie altogether beyond the natural force of the words, and to be of an arbitrary character. He includes in it the proposition that the production of the respective orders was effected (p. 457) during each of "three distinct and successive periods of time; and only during those periods of time;" or again, in one of these, "and not at any other of these;" as, in a series of games at chess, one is done before another begins; or as in a "march-past," one regiment goes before another comes. No doubt there may be a degree of literalism which will even suffice to show that, as "every winged fowl" was produced on the fourth day of the Hexaemeron, therefore the birth of new fowls continually is a contradiction to the text of Genesis. But does not the equity of common sense require us to understand simply that the order of "winged fowl," whatever that may mean, took its place in creation at a certain time, and that from that time its various component classes were in course of production? Is it not the fact that in synoptical statements of successive events, distributed in time for the sake of producing easy and clear impressions, general truth is aimed at, and periods are allowed to overlap? If, with such a view, we arrange the schools of Greek philosophy in numerical order, according to the dates of their inception, we do not mean that one expired before another was founded. If the archæologist describes to us as successive in time the ages of stone, bronze, and iron,† he certainly does not mean that no kinds of stone implement were invented after bronze began, or no kinds of bronze after iron began. When Thucydides said that the ancient limited monarchies were succeeded by tyrannies, he did not mean that all the monarchs died at once, and a set of tyrants, like Deucalion's men, rose up and took their places. Woe be, I should say, to any one who tries summarily to present in series the phases of ancient facts, if they are to be judged under the rule of Professor Huxley.

Proceeding, on what I hold to be open ground, to state my own idea of the true key to the meaning of the Mosaic record, I suggest that

* Because my argument in no way requires universal accordance, what bearing the scorpion may have on any current scientific hypothesis, it is not for me to say.

† I use this enumeration to illustrate an argument, but I must, even in so using it, enter a caveat against its particulars. I do not conceive it to be either probable or historical that, as a general rule, mankind passed from the use of stone implements to the use of bronze, a composite metal, without passing through some intermediate (longer or shorter) period of copper.

it was intended to give moral, and not scientific, instruction to those for whom it was written. That for the Adamic race, recent on the earth, and young in faculties, the traditions here incorporated, which were probably far older than the Book, had a natural and a highly moral purpose in conveying to their minds a lively sense of the wise and loving care with which the Almighty Father, who demanded much at their hands, had beforehand given them much, in the provident adaptation of the world to be their dwelling-place, and of the created orders for their use and rule. It appears to me that, given the very nature of the Scriptures, this is clearly the rational point of view. If it is so, then, it follows, that just as the tradition described earth, air, and heaven in the manner in which they superficially presented themselves to the daily experience of man—not scientifically, but

The common air, the sun, the skies—

so he spoke of fishes, of birds, of beasts, of what man was most concerned with ; and, last in the series, of man himself, largely and generally, as facts of his experience ; from which great moral lessons of wonder, gratitude, and obedience were to be deduced, to aid him in the great work of his life-training.

If further proof be wanting, that what the Mosaic writer had in his mind were the creatures with which Adamic man was conversant, we have it in the direct form of verse 28, which gives to man for meat the fruit of every seed-yielding tree, and every seed-yielding herb, and the dominion of every beast, fowl, and reptile living. There is here a marked absence of reference to any but the then living species.

This, then, is the key to the meaning of the Book, and of the tradition, if, as I suppose, it was before the Book, which seems to me to offer the most probable, and therefore the rational guide to its interpretation. The question we shall have to face is whether this statement so understood, this majestic and touching lesson of the childhood of Adamic man, stands in such a relation to scientific truth, as far as it is now known, as to give warrant to the inference that the guidance under which it was composed was more than that of faculties merely human, at that stage of development, and likewise of information, which belonged to the childhood of humanity.

We have, then, before us one term of the desired comparison. Let us now turn to the other.

And here my first duty is to render my grateful thanks to Professor Huxley for having corrected my either erroneous or superannuated assumption as to the state of scientific opinion on the second and third terms of the fourfold succession of life. As one probable doctor sufficed to make an opinion probable, so the dissent of this eminent man would of itself overthrow and pulverize my proposition that there was a scientific *consensus* as to a sequence like that of Genesis in the production of animal life, as between fishes, birds, mammals, and man. I shall compare the text of Genesis with geological statements; but shall make no attempt, unless this be an attempt, to profit by a *consensus* of geologists.

I suppose it to be admitted on all hands that no perfectly comprehensive and complete correspondence can be established between the terms of the Mosaic text and modern discovery. No one, for instance, could conclude from it that which appears to be generally recognized, that a great reptile-age would be revealed by the Mesozoic rocks.

Yet I think readers, who have been swept away by the torrent of Mr. Huxley's denunciations, will feel some surprise when on drawing summarily into line the main allegations, and especially this ruling order of the Proem, they see how small a part of them is brought into question by Mr. Huxley, and to how large an extent they are favored by the tendencies, presumptions, and even conclusions of scientific inquiry.

First, as to the cosmogony, or the formation of the earth and the heavenly bodies—

1. The first operation recorded in Genesis appears to be the formation of light. It is detached, apparently, from the waste or formless elemental mass (verses 2–5), which is left relatively dark by its withdrawal.

2. Next we hear of the existence of vapor, and of its condensation into water on the surface of the earth (verses 6–10). Vegetation subsequently begins: but this belongs rather to geology than to cosmogony (verses 11, 12).

3. In a new period, the heavenly bodies are declared to be fully formed and visible, dividing the day from the night (verses 14–18).

Under the guidance particularly of Dr. Whewell, I have referred to the nebular hypothesis as confirmatory of this account.

Mr. Huxley has not either denied the hypothesis, or argued against it. But I turn to Phillips's "Manual of Geology," edited and adapted by Mr. Seeley and Mr. Etheridge (1885). It has a section in vol. i. (pp. 15–19) on "Modern Speculations concerning the Origin of the Earth."

The first agent here noticed as contributing to the work of production is the "gas hydrogen in a burning state," which now "forms the enveloping portion of the sun's atmosphere;" whence we are told the inference arises that the earth also was once "incandescent at its surface," and that its rocks may have been "products of combustion." Is not this representation of light with heat for its ally, as the first element in this Speculation, remarkably accordant with the opening of the Proem to Genesis?

Next it appears (*ibid.*) that "the product of this combustion is vapor," which with diminished heat condenses into water, and eventually accumulates "in depressions on the sun's surface so as to form oceans and seas." "It is at least probable that the earth has passed through a phase of this kind" (*ibid.*). "The other planets are apparently more or less like the earth in possessing atmospheres and seas." Is there not here a remarkable concurrence with the second great act of the cosmogony?

Plainly, as I suppose it is agreeable to these suppositions that, as vapor gradually passes into water, and the atmosphere is cleared, the full adaptation of sun and moon by visibility for their functions should come in due sequence, as it comes in Gen. i. 14–18.

Pursuing its subject, the Manual proceeds (p. 17): "This consideration leads up to what has been called the nebular hypothesis," which "supposes that, before the stars existed, the materials of which they consist were diffused in the heavens in a state of vapor" (*ibid.*). The text then proceeds to describe how local centers of condensation might throw off rings, these rings break into planets, and the planets, under conditions of sufficient force, repeat the process, and thus produce satellites like those of Saturn, or like the moon.

I therefore think that, so far as cosmogony is concerned, the effect of Mr. Huxley's paper is not by any means to leave it as it was, but to leave it materially fortified by the Manual of Geology, which I understand to be a standard of authority at the present time.

Turning now to the region of that science, I understand the main statements of Genesis, in successive order of time, but without any measurement of its divisions, to be as follows:

1. A period of land, anterior to all life (verses 9, 10).
2. A period of vegetable life, anterior to animal life (verses 11, 12).
3. A period of animal life, in the order of fishes (verse 20).
4. Another stage of animal life, in the order of birds.
5. Another, in the order of beasts (verses 24, 25).
6. Last of all, man (verses 26, 27).

Here is a chain of six links, attached to a previous chain of three. And I think it not a little remarkable that of this entire succession, the only step directly challenged is that of numbers four and five, which (p. 457) Mr. Huxley is inclined rather to reverse. He admits distinctly the seniority of fishes. How came that seniority to be set down here? He admits as probable upon present knowledge, in the person of *Homo sapiens*, the juniority of man (p. 455). How came this juniority to be set down here? He proceeds indeed to describe an opposite opinion concerning man as holding exactly the same rank as the one to which he had given an apparent sanction (*ibid.*). As I do not precisely understand the bearing of the terms he uses, I pass them by, and I shall take the liberty of referring presently to the latest authorities, which he has himself suggested that I should consult. But I add to the questions I have just put this other inquiry. How came the Mosaic writer to place the fishes and the men in their true relative positions not only to one another, and not only to the rest of the animal succession, but in a definite and that a true relation of time to the origin of the first plant-life, and to the colossal operations by which the earth was fitted for them all? Mr. Huxley knows very well that it would be in the highest degree irrational to ascribe this correct distribution to the doctrine of chances; nor will the stone of Sisyphus of itself constitute a sufficient answer to inquiries which are founded, not upon a fanciful attempt to equate every word of the Proem with every *dictum* of science, but upon those principles of probable reasoning by which all rational lives are and must be guided.

I find the latest published authority on geology in the Second or Mr. Etheridge's volume of the Manual * of Professor Phillips, and by this I will now proceed to test the sixfold series which I have ventured upon presenting.

First, however, looking back for a moment to a work, obviously of the highest authority,† on the geology of its day, I find in it a table of the order of appearance of animal life upon the earth, which, begining with the oldest, gives us—

1. Invertebrates	4. Birds
2. Fishes	5. Mammals
3. Reptiles	6. Man.

I omit all reference to specifications, and speak only of the principal lines of division.

In the Phillips-Etheridge Manual, beginning as before with the oldest, I find the following arrangement, given partly by statement and partly by diagram:

1. "The Azoic or Archæan time of Dana;" called pre-Cambrian by other physicists (pp. 3, 5).

2. A commencement of plant-life indicated by Dana as anterior to invertebrate animal life; long anterior to the vertebrate forms, which alone are mentioned in Genesis (pp. 4, 5).

3. Three periods of invertebrate life.

4. Age of fishes.

5. Age of reptiles.

6. Age of mammals, much less remote.

7. Age of man, much less remote than mammals.

As to birds, though they have not a distinct and separate age assigned them, the Manual (vol. i. ch. xxv. pp. 511–20) supplies us very clearly with their place in "the succession of animal life." We are here furnished with the following series, after the fishes: 1. Fossil reptiles (p. 512); 2. Ornithosauria (p. 517); they were "flying animals, which combined the characters of reptiles with those of birds;" 3. The first birds of the secondary rocks with "feathers in all respects similar to those of existing birds" (p. 518); 4. Mammals (p. 520).

* Phillips's "Manual of Geology" (vol. ii.) part ii., by R. Etheridge, F. R. S. New edition, 1885.

† "Palæontology," by Richard Owen (now Sir Richard Owen, K. C. B.). Second edition, p. 5, 1861.

I have been permitted to see in proof another statement from an authority still more recent, Professor Prestwich, which is now passing through the press. In it (pp. 80, 81) I find the following seniority assigned to the orders which I here name:

1. Plants (cryptogamous)
2. Fishes
3. Birds
4. Mammals
5. Man

It will now, I hope, be observed that, according to the probable intention of the Mosaic writer, these five orders enumerated by him correspond with the state of geological knowledge, presented to us by the most recent authorities, in this sense; that the origins of these orders respectively have the same succession as is assigned in Genesis to those representatives of the orders, which alone were probably known to the experience of Adamic man. My fourfold succession thus grows into a fivefold one. By placing before the first plant-life the Azoic period, it becomes sixfold. And again by placing before this the principal stages of the cosmogony, it becomes, according as they are stated, nine or tenfold; every portion holding the place most agreeable to modern hypothesis and modern science respectively.

I now notice the points in which, so far as I understand, the text of the Proem, as it stands, is either incomplete or at variance with the representations of science:

1. It does not notice the great periods of invertebrate life standing between (1) and (2) of my last enumeration.

2. It also passes by the great age of Reptiles, with their antecessors the *Amphibia*, which come between (2) and (3). The secondary or Mesozoic period, says the Manual (i. 511), "has often been termed the age of Reptiles."

3. It mentions plants in terms which, as I understand from Professor Huxley and otherwise, correspond with the later, not the earlier, forms of plant-life.

4. It mentions reptiles in the same category with its mammals.

Now, as regards the first two heads, these omissions, enormous with reference to the scientific record, are completely in harmony with the probable aim of the Mosaic writer, as embracing only the formation of the objects and creatures with which early man was conversant. The introduction of these orders, invisible and unknown, would have been not agreeable, but injurious, to his purpose.

As respects the third, it will strike the reader of the Proem that plant-life (verses 11, 12) is mentioned with a particularity which is not found in the accounts of the living orders; nor in the second notice of the Creation, which appears, indeed, pretty distinctly to refer to recent plant-life (Gen. ii., 5, 8, 9). Questions have been raised as to the translation of these passages, which I am not able to solve. But I bear in mind the difficulties which attend both oral traditions and the conservation of ancient MS., and I am not in any way troubled by the discrepancy before us, if it be a discrepancy, as it is the general structure and effect of the Mosaic statement on which I take my stand.

With regard to reptiles, while I should also hold by my last remark, the case is different. They appear to be mentioned as contemporary with mammals, whereas they are of prior origin. But the relative significance of the several orders evidently affected the method of the Mosaic writer. Agreeably to this idea, insects are not named at all. So reptiles were a family fallen from greatness; instead of stamping on a great period of life its leading character, they merely skulked upon the earth. They are introduced, as will appear better from the LXX than from the A.V. or R.V., as a sort of appendage to mammals. Lying outside both the use and the dominion of man, and far less within his probable notice, they are not wholly omitted like insects, but treated apparently in a loose manner as not one of the main features of the picture which the writer meant to draw. In the Song of the Three Children, where the four principal orders are recited after the series in Genesis, reptiles are dropped altogether, which suggests either that the present text is unsound, or, perhaps more probably, that they were deemed a secondary and insignificant part of it. But, however this case may be regarded, of course I can not draw from it any support to my general contention.

I distinguish, then, in the broadest manner, between Professor Huxley's exposition of certain facts of science, and his treatment of the Book of Genesis. I accept the first, with the reverence due to a great teacher from the meanest of his hearers, as a needed correction to myself, and a valuable instruction for the world. But, subject to that correction, I adhere to my proposition respecting the fourfold succession in the Proem; which further I extend to a fivefold succession respecting life, and to the great stages of the cosmogony to boot. The five origins, or first appearances of plants, fishes, birds, mammals and man, are given to us in Genesis in the order of succession, in which they are also given by the latest geological authorities.

It is, therefore, by attaching to words a sense they were never meant to bear, and by this only, that Mr. Huxley establishes the parallel (so to speak), from which he works his heavy artillery. Land-population is a phrase meant by me to describe the idea of the Mosaic writer, which I conceive to be that of the animals familiarly known to early man. But, by treating this as a scientific phrase, it is made to include extinct reptiles, which I understand Mr. Huxley (*P. S. M.* p. 453) to treat as being land-animals; as, by taking birds of a very high formation, it may be held that mammal forms existed before such birds were produced. These are artificial contradictions, set up by altering in its essence one of the two things which it is sought to compare.

If I am asked whether I contend for the absolute accordance of the Mosaic writer, as interpreted by me, with the facts and presumptions of science, as I have endeavored to extract them from the best authorities, I answer that I have not endeavored to show either that any accordance has been demonstrated, or that more than a substantial accordance—an accordance in principal relevant particulars—is to be accepted as shown by probable evidence.

In the cosmogony of the Proem, which stands on a distinct footing as lying wholly beyond the experience of primitive man, I am not aware that any serious flaw is alleged; but the nebular hypothesis with which it is compared appears to be, perhaps from the necessity of the case, no more than a theory; a theory, however, long discussed, much favored, and widely accepted in the scientific world.

In the geological part, we are liable to those modifications or displacements of testimony which the future progress of the science may produce. In this view its testimony does not in strictness pass, I suppose, out of the category of probable into that of demonstrative evidence. Yet it can hardly be supposed that careful researches, and reasonings strictly adjusted to method, both continued through some generations, have not in a large measure produced what has the character of real knowledge. With that real knowledge the reader will now have seen how far I claim for the Proem to Genesis, fairly tried, to be in real and most striking accordance.

And this brings me to the point at which I have to observe that Mr. Huxley, I think, has not mastered, and probably has not tried to master, the idea of his opponent as to what it is that is essentially embraced in the idea of a Divine revelation to man.

So far as I am aware, there is no definition, properly so called, of revelation either contained in Scripture or established by the general and permanent consent of Christians. In a word polemically used, of indeterminate or variable sense, Professor Huxley has no title to impute to his opponent, without inquiry, anything more than it must of necessity convey.

But he seems to assume that revelation is to be conceived of as if it were a lawyer's parchment, or a sum in arithmetic, wherein a flaw discovered at a particular point is *ipso facto* fatal to the whole. Very little reflection would show Professor Huxley that there may be those who find evidences of the communication of Divine knowledge in the Proem to Genesis as they read it in their Bibles, without approaching to any such conception. There is the uncertainty of translation; translators are not inspired. There is the difficulty of transcription; transcribers are not inspired, and an element of error is inseparable from the work of a series of copyists. How this works in the long courses of time we see in the varying texts of the Old Testament, with rival claims not easy to adjust. Thus the authors of the recent Revision * have had to choose in the Massoretic text itself between

* Preface to the Old Testament, p. vi.

different readings, and "in exceptional cases" have given a preference to the Ancient Versions. Thus, upon practical grounds quite apart from the higher questions concerning the original composition, we seem at once to find a human element in the sacred text. That there is a further and larger question, not shut out from the view even of the most convinced and sincere believers, Mr. Huxley may perceive by reading, for example, Coleridge's "Confessions of an Inquiring Spirit." The question whether this Proem bears witness to a Divine communication, to a working beyond that of merely human faculties in the composition of the Scriptures, is essentially one for the disciples of Bishop Butler; a question, not of demonstrative, but of probable evidence. I am not prepared to abandon, but rather to defend, the following proposition. It is perfectly conceivable that a document penned by the human hand, and transmitted by human means, may contain matter questionable, uncertain, or even mistaken, and yet may by its contents as a whole present such πίστεις, such moral proofs of truth Divinely imparted, as ought irrefragably *pro tanto* to command assent and govern practice. A man may possibly admit something not reconciled, and yet may be what Mr. Huxley denounces as a Reconciler.

I do not suppose it would be feasible, even for Professor Huxley, taking the nebular hypothesis and geological discovery for his guides, to give, in the compass of the first twenty-seven verses of Genesis, an account of the cosmogony, and of the succession of life in the stratification of the earth, which would combine scientific precision of statement with the majesty, the simplicity, the intelligibility, and the impressiveness of the record before us. Let me modestly call it, for argument's sake, an approximation to the present presumptions and conclusions of science. Let me assume that the statement in the text as to plants, and the statement of verses 24, 25 as to reptiles, can not in all points be sustained; and yet still there remain great unshaken facts to be weighed. First, the fact that such a record should have been made at all. Secondly, the fact that, instead of dwelling in generalities, it has placed itself under the severe conditions of a chronological order, reaching from the first *nisus* of chaotic matter to the consummated production of a fair and goodly, a furnished and a peopled world. Thirdly, the fact that its cosmogony seems, in the light of the nineteenth century, to draw more and more of countenance from the best natural philosophy; and fourthly, that it has described the successive origins of the five great categories of present life, with which human experience was and is conversant, in that order which geological authority confirms. How came these things to be? How came they to be, not among Accadians, or Assyrians, or Egyptians, who monopolized the stores of human knowledge when this wonderful tradition was born; but among the obscure records of a people who, dwelling in Palestine for twelve hundred years from their sojourn in the valley of the Nile, hardly had force to stamp even so much as their name upon the history of the world at large, and only then began to be admitted to the general communion of mankind when their Scriptures assumed the dress which a Gentile tongue was needed to supply? It is more rational, I contend, to say that these astonishing anticipations were a God-given supply, than to suppose that a race, who fell uniformly and entirely short of the great intellectual development* of antiquity, should here not only have equaled and outstripped it, but have entirely transcended, in kind even more than in degree, all known exercise of human faculties.

Whether this was knowledge conveyed to the mind of the Mosaic author, I do not presume to determine. There has been, in the belief of Christians, a profound providential purpose, little or variously visible to us, which presided, from Genesis to the Apocalypse, over the formation of the marvelous compound, which we term the Holy Scriptures. This we wonderingly embrace without being much perplexed by the questions which are raised on them; for instance, by the question, In what exact relation the books of the Apocrypha, sometimes termed deutero-canonical, stand to the books of the Hebrew Canon. Difficulties of detail, such as may (or ultimately may not) be found to exist in the Proem to Genesis, have much the same relation to the evidence of revealed knowledge in this record, as the spots in the sun to his all-unfolding and sufficing light. But as to the Mosaic writer himself, all I presume to accept is the fact that he put upon undying record, in this portion of his work, a series of particulars which, interpreted in the growing light of modern knowledge, require from us, on the whole, as reasonable men, the admission that we do not see how he could have written them, and that in all likelihood he did not write them, without aid from the guidance of a more than human power. It is in this guidance, and not necessarily or uniformly in the consciousness of the writer, that, according to my poor conception, the idea of Revelation mainly lies.

And now one word on the subject of Evolution. I can not follow Mr. Huxley in his minute acquaintance with Indian sages, and I am not aware that Evolution has a place in the greater number of the schools of Greek philosophy. Nor can I comprehend the rapidity with which persons of authority have come to treat the Darwinian hypothesis as having reached the final stage of demonstration. To the eye of a looker-on their pace and method seem rather too much like a steeplechase. But this may very well be due to their want of appropriate knowledge and habits of thought. For myself, in my loose and uninformed way of looking at Evolution, I feel only too

* I write thus bearing fully in mind the unsurpassed sublimity of much that is to be found in the Old Testament. The consideration of this subject would open a wholly new line of argument, which the present article does not allow me to attempt.

much biased in its favor, by what I conceive to be its relation to the great argument of design.*

Not that I share the horror with which some men of science appear to contemplate a multitude of what they term "sudden" acts of creation. All things considered, a singular expression: but one, I suppose, meaning the act which produces, in the region of nature, something not related by an unbroken succession of measured and equable stages to what has gone before it. But what has equality or brevity of stage to do with the question how far the act is creative? I fail to see, or indeed am somewhat disposed to deny, that the short stage is less creative than the long, the single than the manifold, the equable than the jointed or graduated stage. Evolution is, to me, series with development. And like series in mathematics, whether arithmetical or geometrical, it establishes in things an unbroken progression; it places each thing (if only it stand the test of ability to live) in a distinct relation to every other thing, and makes each a witness to all that have preceded it, a prophecy of all that are to follow it. It gives to the argument of design, now called the teleological argument, at once a wider expansion, and an augmented tenacity and solidity of tissue. But I must proceed.

I find Mr. Huxley asserting that the things of science, with which he is so splendidly conversant, are "susceptible of clear intellectual comprehension" (*P. S. M.* p. 459). Is this rhetoric, or is it a formula of philosophy? If the latter, will it bear examination? He pre-eminently understands the relations between those things which Nature offers to his view; but does he understand each thing in itself, or *how* the last term but one in an evolutional series passes into and becomes the last? The seed may produce the tree, the tree the branch, the branch the twig, the twig the leaf or flower; but can we understand the slightest mutation or growth of Nature in itself? can we tell *how* the twig passes into leaf or flower, one jot more than if the flower or leaf, instead of coming from the twig, came directly from the tree or from the seed?

I can not but trace some signs of haste in Professor Huxley's assertion that, outside the province of science (*ibid.*), we have only imagination, hope, and ignorance. Not, as we shall presently see, that he is one of those who rob mankind of the best and highest of their inheritance, by denying the reality of all but material objects. But the statement is surely open to objection, as omitting or seeming to omit from view the vast fields of knowledge only probable, which are not of mere hope, nor of mere imagination, nor of mere ignorance;

* "Views like these, when formulated by religious instead of scientific thought, make more of Divine Providence and fore-ordination, than of Divine intervention; but perhaps they are not the less theistical on that account." (From the very remarkable Lectures of Professor Asa Gray on *Natural Science and Religion*, p. 77. Scribner, New York, 1880.)

which include alike the inward and the outward life of man; within which lie the real instruments of his training, and where he is to learn how to think, to act, to be.

I will now proceed to notice briefly the last page of Professor Huxley's paper, in which he drops the scientist and becomes simply the man. I read it with deep interest, and with no small sympathy. In touching upon it, I shall make no reference (let him forgive me the expression) to his "damnatory clauses," or to his harmless menace, so deftly conveyed through the prophet Micah, to the public peace.

The exaltation of Religion as against Theology is at the present day not only so fashionable, but usually so domineering and contemptuous, that I am grateful to Professor Huxley for his frank statement (p. 459) that Theology is a branch of science; nor do I in the smallest degree quarrel with his contention that Religion and Theology ought not to be confounded. We may have a great deal of Religion with very little Theology; and a great deal of Theology with very little Religion. I feel sure that Professor Huxley must observe with pleasure how strongly practical, ethical, and social is the general tenor of the three synoptic Gospels; and how the appearance in the world of the great doctrinal Gospel was reserved to a later stage, as if to meet a later need, when men had been toned anew by the morality and, above all, by the life of our Lord.

I am not, therefore, writing against him, when I remark upon the habit of treating Theology with an affectation of contempt. It is nothing better, I believe, than a mere fashion; having no more reference to permanent principle than the mass of ephemeral fashions that come from Paris have with the immovable types of Beauty. Those who take for the burden of their song "Respect Religion, but despise Theology," seem to me just as rational as if a person were to say "Admire the trees, the plants, the flowers, the sun, moon, or stars, but despise Botany, and despise Astronomy." Theology is ordered knowledge; representing in the region of the intellect what religion represents in the heart and life of man. And this religion, Mr. Huxley says a little further on, is summed up in the terms of the prophet Micah (vi. 8): "Do justly, and love mercy, and walk humbly with thy God." I forbear to inquire whether every addition to this—such, for instance, as the Beatitudes—is (*N. C.* p. 460) to be proscribed. But I will not dispute that in these words is conveyed the true ideal of religious discipline and attainment. They really import that identification of the will which is set out with such wonderful force in the very simple words of the "Paradiso"—

In la sua volontade è nostra pace,

and which no one has more beautifully described than (I think) Charles Lamb: "He gave his heart to the Purifier, his will to the Will that governs the universe." It may be we shall find that Christianity itself is in some sort a scaffolding, and that the final building is a pure and perfect theism: when* the kingdom shall be "delivered up to God," "that God may be all in all." Still, I can not help being struck with an impression that Mr. Huxley appears to cite these terms of Micah, as if they reduced the work of religion from a difficult to a very easy performance. But look at them again. Examine them well. They are, in truth, in Cowper's words—

> Higher than the heights above,
> Deeper than the depths beneath.

Do justly, that is to say, extinguish self; love mercy, cut utterly away all the pride and wrath, and all the cupidity, that make this fair world a wilderness; walk humbly with thy God, take His will and set it in the place where thine own was used to rule. "Ring out the old, ring in the new." Pluck down the tyrant from his place; set up the true Master on His lawful throne.

There are certainly human beings, of happy composition, who mount these airy heights with elastic step, and with unbated breath.

> Sponte suâ, sine lege, fidem rectumque colebat.†

This comparative refinement of nature in some may even lead them to undervalue the stores of that rich armory, which Christianity has provided to equip us for our great life-battle. The text of the prophet Micah, developed into all the breadth of St. Paul and St. Augustine, is not too much—is it not often all too little?—for the needs of ordinary men.

I must now turn, by way of epilogue, to Professor Max Müller; and I hope to show him that on the questions which he raises we are not very far apart. One grievous wrong, indeed, he does me in (apparently) ascribing to me the execrable word "theanthromorphic" (*N. C.* p. 920), of which I wholly disclaim the paternity, and deny the use. Then he says, I warn him not to trust too much to etymology (p. 921). Not so. But only not to trust to it for the wrong purpose, in the wrong place: just as I should not preach on the virtue and value of liberty to a man requiring handcuffs. I happen to bear a name known, in its genuine form, to mean stones or rocks frequented by the gled; and probably taken from the *habitat* of its first bearer. Now, if any human being should ever hereafter make any inquiry about me, trace my name to its origin, and therefore describe the situation of my dwelling, he would not use etymology too much, but would use it ill. What I protest against is a practice, not without example, of taking the etymology of mythologic names in Homer, and thereupon supposing that in all cases we have thus obtained a guide to their Homeric sense. The place of Nereus in the mind of the poet is indisputable; and here etymology helps us. But when a light-etymology is found for Hera, and it is therefore asserted

* 1 Cor. xv. 24, 28.

† Ovid, "Metam." i. 90.

that in Homer she is a light-goddess, or when, because no one denies that *Phoibos* is a light-name, therefore the Apollo of Homer was the Sun, then indeed, not etymology, but the misuse of etymology, hinders and misleads us. In a question of etymology, however, I shall no more measure swords with Mr. Max Müller than with Mr. Huxley in a matter of natural science, and this for the simple reason that my sword is but a lath. I therefore surrender to the mercy of this great philologist the derivation of *dine* and *dîner* from *déjeuner;* which may have been suggested by the use of the word *dine* in our Bible (as John xxi. 12) for breakfasting; a sense expressed by La Bruyère (xi.) in the words, *Cliton n'a jamais eu, toute sa vie, que deux affaires, qui sont de dîner le matin, et de souper le soir.*

But, Mr. Max Müller says, I have offended against the fundamental principles of comparative mythology (*N. C.* p. 919). How, where, and why, have I thus tumbled into mortal sin? By attacking solarism. But what have I attacked, and what has he defended? I have attacked nothing but the exclusive use of the solar theory to solve all the problems of the Aryan religions; and it is to this monopolizing pretension that I seek to apply the name of solarism, while admitting that "the solar theory has a most important place" in solving such problems (*N. C.* p. 704). But my *vis-à-vis*, whom I really can not call my opponent, declares (*N. C.* p. 919) that the solarism I denounce is not his solarism at all; and he only seeks to prove that "certain portions of ancient mythology have a directly solar origin." So it proves that I attack only what he repudiates, and I defend what he defends. That is, I humbly subscribe to a doctrine, which he has made famous throughout the civilized world.

It is only when a yoke is put upon Homer's neck, that I presume to cry "hands off." The Olympian system, of which Homer is the great architect, is a marvelous and splendid structure. Following the guidance of ethnological affinities and memories, it incorporates in itself the most diversified traditions, and binds them into an unity by the plastic power of an unsurpassed creative imagination. Its dominating spirit is intensely human. It is therefore of necessity thoroughly anti-elemental. Yet, when the stones of this magnificent fabric are singly eyed by the observer, they bear obvious marks of having been appropriated from elsewhere by the sovereign prerogative of genius; of having had an anterior place in other systems; of having belonged to Nature-worship, and in some cases to Sun-worship; of having been drawn from many quarters, and among them from those which Mr. Max Müller excludes (p. 921): from Egypt, and either from Palestine, or from the same traditional source, to which Palestine itself was indebted. But this is not the present question. As to the solar theory, I hope I have shown either that our positions are now identical, or that, if there be a rift between them, it is so narrow that we may conveniently shake hands across it.—*Nineteenth Century.*

ANIMAL WEATHER-LORE.

By CHARLES C. ABBOTT, M. D.

HAPPILY there still remain a few of those great, cavernous, open fireplaces, flanked by high-backed settles, whereon the young people love to lounge, while their elders, resting from the day's labors, talk drowsily of old times, recount the adventures of their youth, and repeat the tales of their grandfathers. As one of such young people, I have passed many long winter evenings, listening eagerly to what the septuagenarians might relate, and occasionally venturing a question or two, that more light might be thrown upon obscure portions of remarks made at the time. Then, particularly, are we likely to hear much of that very curious animal weather-lore that, for the past two centuries, has been handed down from father to son. Time and again, as the weather chanced to be discussed, I have heard some uncouth rhyme repeated, usually prefaced with the remark, "You know the old saying."

That all animals are more or less affected by coming atmospheric changes is unquestionable. This simple fact has been recognized the world over, but, unlike many other simple facts, has not resulted in leading to any important discoveries. It has, however, given rise to the innumerable sayings to which I have referred.

Inasmuch as the animal weather-lore current in England and Sweden dates far prior to the settlement of this country by the Swedes and English, it would seem probable that such sayings as now are or recently were current in South and Central New Jersey are merely adaptations of English and Swedish weather-lore to our fauna, just as the European names of the commoner birds found there were applied to those American species most closely resembling them ; and so, any rhyme or brief saying referring to them would be applied to the analogous bird found here. This is eminently reasonable, for, if the given habit, voice, or other peculiarity of a European bird did, or was supposed to, indicate a given meteorological condition, the same rule should hold good in America. As a matter of fact, however, I can find no similarity between the English and Swedish and the American weather-lore, except such as applies to domestic animals ; nor do I find any common English sayings in use.

That which I have heard, and have recorded from time to time, appears to have originated where now, or where it lately was, in use. To a great extent, I believe it to be original with the descendants of the immigrants that settled Central New Jersey and the country generally about Philadelphia ; but a portion of it, very possibly, was derived from the Indians.

At present, a portion of this weather-lore is repeated as nursery rhymes, and it is due to this that it has been preserved to the present time; and, so far as I have been able to determine, not one of the rhymes or sayings has ever been published. That among the earliest papers and almanacs of the country there may be found some of them, or slightly different versions of the same, is probable, but my searchings therefor, in the larger libraries, have not resulted in any such discoveries.

The main interest, however, in connection with weather-lore, is to determine whether they do or do not correctly represent the relationship of the animals mentioned to the given condition of the weather. In other words, is the zoölogy of the weather-lore misrepresented or not? I am forced to declare that, as a rule, those who by virtue of their ingenuity framed these rhymes and brief sayings did not correctly interpret Nature.

Very many of the early English settlers were, no doubt, excellent observers; but they appear, at times, to have more desired to be looked upon as weather-prophets than as naturalists, and strove to have glib nonsense-sayings pass current as evidence of their wisdom, instead of taking pains to correctly interpret the course of Nature and determine the relation of animal life to its environment.

Often, during my rambles in the neighborhood, I have questioned the few remaining descendants of the original settlers concerning the local weather-proverbs, and I find the impression is still prevalent that the purport of all these sayings is substantially correct, and therefore, to a great degree, that my neighbors are laboring under erroneous impressions. "Is there not wisdom in a multitude of counselors?" they ask; and I, standing alone, am voted the fool, while they pose as sages.

Let us consider this weather-lore, bit by bit, as I have gathered it from time to time, and discuss its merits, if it possesses any, and also its absurdities.

Of such sayings as refer to our domestic animals, the following are the most noteworthy. Of the cow, I have heard it said:

"When a cow tries to scratch its ear,
It means a shower is very near";

and again—

"When it thumps its ribs with its tail,
Look out for thunder, lightning, hail."

As is now pretty well known, a short time before a shower in summer, there is often a highly electrical condition of the atmosphere, which makes all animals more or less uneasy. Therefore, the lashing of the tail, if not merely to brush away flies, may refer to this uneasiness, and so, too, the ears may be more sensitive than the general surface of the body. This is a probable explanation, but, after all, it is not proved that the cow at such a time suffers as much from it as is supposed; nor is it easy to see how the flagellation of a very insignificant part of the body can ease a painful sensation common to the entire surface. On the other hand, it is certain that flies and other troublesome insects are sensitive to atmospheric changes, even a slight lowering of the temperature, such as no mammal would appreciate; and for an hour or two before a shower, for this reason, they congregate in extraordinary numbers about animals—horses and cows particularly. I have thought that they seek the cows for warmth when the air suddenly cools; and is it not more than probable that the nervousness on the part of the animal, shown by frantic efforts to scratch its ears with its hind-feet and the lashing of its tail, has to do with the excess of irritation caused by innumerable flies, and not with any unusual electrical titillation? If so, the cow's action is still indicative of an approaching change in the weather, and so far may be claimed as a sign of such change, but the connection of the two facts is not such a one as is usually given. It is an indirect, not direct, indication of the prophesied rain-storm. But bearing heavily on the subject is the unquestionable fact that an unusual number of flies often suddenly make their appearance, and torment cattle almost beyond endurance, during the four or six weeks of drought which in summer, early or late, we are so sure to have. In such cases the signs fail. I have asked many a farmer how this could be, and the one reply that I have received in every case is that "there was a shower in the neighborhood." It usually happened, however, that the neighborhood was as parched as we were, and, seeing the signs fail with them, they were covetous of the shower they supposed that we had had. Perhaps it is with such indications of changes in the weather as it has been said of autumnal proofs of the character of the approaching winter. Miles Overfield once remarked, "When the signs get to failin' 'long in the fall, there'll be no tellin' about the winter."

Of pigs, I have heard it said, very frequently—

"When swine carry sticks,
The clouds will play tricks";

but that—

"When they lie in the mud,
No fears of a flood."

The first of these couplets is of twofold interest. I have watched them for years, to see what purport this carrying of sticks and bunches of grass might have, and have only learned that it has nothing whatever to do with the weather, or at least with coming rain-storms. The drought of summer is so far a convenience as to throw light upon this habit, as it did upon the uneasy cows. Pigs carry sticks as frequently then as during wet weather, or just preceding a shower. Furthermore, these gathered twigs are not brought together as though to make a nest, but are scattered about in a perfectly aimless manner. For some cause, the animal is uneasy, and takes this curious method of relieving itself. The probabilities are that it is a survival of some habit common to swine in their feral condition, just as we see a dog turn about half a dozen times before lying down.

In an interesting paper on local weather-lore, read by Mr. Amos W. Butler before the American Association for the Advancement of Science, during the Philadelphia meeting of 1884, the author has another version of this saying: "When hogs gather up sticks and carry them about, expect cold weather." This is wholly at variance with what I have observed, for my memoranda record this habit almost wholly during the hot weather, and this must necessarily be the rule with New Jersey swine, or the local weather-prophets would not have coined the verse as I have given it.

As to the other couplet, it is about as near meaningless as any saying can well be. Some rustic rhymer, a century ago, may have added it as a piece of fun, but it has stuck most persistently. As it stands now, it has stood for quite one hundred years.

In reference to the dog, I have heard the following more pretentious stanza, which has now taken its place among our nursery rhymes, where, indeed, it is best fitted to remain:

> "When drowsy dogs start from their sleep,
> And bark at empty space,
> 'Tis not a dream that prompts them to,
> But showers come on apace."

Here we have essentially the same inference as in that of the rhyme about cows, but it is not to be explained away so readily. Such acts, as described, can not be attributed to annoyance by flies, for they too often emerge from dark quarters, where they have been unmolested; but the all-important fact must not be overlooked that such acts are not confined to summer. If they were, the electrical theory might be advanced with some confidence. From what I have noticed in such dogs as I have owned, the habit of dreaming, which in the rhyme is denied to be the explanation, is probably the key to the mystery. Again, statistics show that the correspondence between such habits and sudden showers is only what we should expect in the way of coincidences. Dogs certainly are not to be considered as reliable barometers.

The same may be said of the domestic cat. Its movements have all been carefully noted, and the yawning, stretching, scratching, and waving of the tail appear to have been accredited with some special meteorological significance. Careful observation has not confirmed any of these impressions. Table-legs are scratched time and again by Tom or Tabby, and no rain falls for twenty-four or forty-eight hours. They stretch themselves after a nap, lick their sides and wash their faces with the same regularity in midwinter as in midsummer, yet it is only showers, and not snow-storms, which these actions are supposed to predict.

When in summer the signs fail, my country friends conveniently forget the remark they have made; but, if the day does prove showery, my non-combative neighbors take much delight in repeating over and over again, "I told thee so," with a suggestive emphasis, showing how much, like other people, they love to gain a victory, if open warfare can be avoided.

The only weather-rhyme referring to a cat that I have heard, and which is essentially the same as that about dogs, runs thus:

> "When Tabby claws the table-legs,
> She for a summer shower begs."

That is, begs it will hurry; with no doubt in her mind of its possibly disappointing her.

The weather-lore of the commoner wild animals is of much more general interest. Weather-sayings referring to animals do not appear to have been so numerous as are those referring to birds. I have been able to learn of but three examples. In reference to minks and weasels, I have heard it said—and possibly others may be familiar with this mystic rhyme—

> "When storm-winds blow and night is black,
> The farmer may a pullet lack;
> But, if the moon is shining clear,
> No mink or weasel dares come near."

This involves an interesting phase of the life-history of these animals; for while they probably can see a little when it is quite dark, and are safely guided by the sense of smell, nevertheless, the experience of trappers about home proves that they do wander about during moonlight nights. Indeed, on careful inquiry, it seems that the trapper generally anticipates better success during the moonlit nights than when it is very dark. I strongly suspect that the truth lies in the fact that, when it is dark and stormy, the watchful house-dog is not on the alert, and thus the cunning weasel or mink is free to raid upon the poultry-house and feast upon the pullet that it seizes. How my neighbors will take to this explanation I can only surmise. Like other people, they fight vigorously for the opinions they have cherished through life. The musk-rat and gray squirrels have given rise to many trite sayings, and have long been looked upon as weather-prophets, but that they are nothing of the sort I have elsewhere* endeavored to show.

The following may or may not be a local saying:

> "When flying-squirrels run on ground,
> The clouds'll pass you by, be bound."

What this may mean has been a question with me for a long time. It is a common remark, either in this or a simpler form, and many, who have little faith in pigs or dogs as weather-prophets, build largely

* "Rambles about Home," p. 73, D. Appleton & Co., New York, 1884.

upon the habits of the flying-squirrel. The saying itself implies that a drought exists at the time that these animals frequent the ground rather than the trees, coming, of course, thereto, in order to find food. If the saying be true, the summer food of the flying-squirrel must be more plentiful on the ground than in the tops of the tallest trees. What that food is exactly, I am not aware; nor have I had any opportunity to verify the statement that flying-squirrels frequent the ground during "dry spells." Those that I have seen, near home, are so strictly crepuscular that only the initial movements of their nocturnal journeys are readily traced; but, whenever I have seen them sally from their retreats, it was to take a tree-top route for several rods and then to be lost to sight. Take the year through, it is probable that they seldom come to the ground to forage. When they do so, is it an evidence of continued dry weather? I can neither contradict nor affirm; but are not the probabilities against such being the case?

Speaking of the opossum, it is said that, if found in autumn in hollow trees, the winter will be milder than if occupying a burrow in the ground.

This seems to be very reasonable, and would pass admirably as a weather-sign, but for one unfortunate circumstance. While you may find one or more in a tree, your neighbor may find as many in the ground. I have known this to be the case more than once. Under these circumstances, meet your neighbor at the line-fence and compare notes. What about the winter?

From their greater abundance and never-failing presence, it might be thought that the weather-lore of birds would be much more elaborate than that referring to other classes of animals; but my observations do not confirm this. There are simply a greater number of sayings current, and fully one half are too trivial to repeat. It would seem as if a weather-lore possibly of Indian origin and referring to birds then abundant, but now wholly wanting, was current more than a century ago. These sayings were subsequently applied to other species, nearly or more remotely allied, and whatever meaning they may originally have had has been lost; but the apparent absurdity of such "proverbs," as now used, seems never to have occurred to those who repeat them.

That the dusting of chickens, cackling of geese, and the "pot-racking" of Guinea-hens have not given rise to an elaborate series of weather-proverbs is, I think, surprising. The only familiar reference to the chicken heard about home is that the rooster, crowing at night, says, "Christmas—coming—on!" It does appear that the midnight crowing of cocks is more frequently heard in December than in June; but, so far as the meaning is concerned, it unfortunately happens that the nocturnal crowing is as often heard in January as in December. Calling attention to this, I was once gravely assured that the cocks crew differently then, and said, "Christmas—come—and—gone!" I accepted the explanation. This is not a weather matter, but is not irrelevant, as it shows how very common it once was to couple any unusual occurrence with something sooner or later to happen, and therefore, in the matter of weather especially, to claim it as prophetic of that event.

Of the examples of weather-lore of birds, the following are not uncommonly heard in Central New Jersey. Of the cardinal-grossbeak, or winter redbird, it is said:

> "The redbird lies, without regret:
> However dry, it whistles 'wet!'"

That is, the bird is credited with knowing it will not rain, and teases the farmer by singing "wet" in his ears all day. Others put another meaning on the redbird's note, and claim it to be a sure sign of rain. This is more like the ordinary sayings commonly heard, and let us give it a moment's consideration. At present, the time of year when the cardinal-birds sing least is during the hot summer months. Not that they are absolutely mute for even a few days at a time, but relatively so as compared with their joyous strains through autumn and winter; and again, early in summer, when they are nesting, these birds, like robins, are more apt to sing directly after a shower than at any other time.

So much for the gay cardinal as a weather-prophet. The rare summer redbird—a tanager—which also utters a whistling note, well described by the syllable "wet," shortly and sharply expressed, is likewise said to prophesy rain. The probabilities are that the note of the redbird, cardinal and summer, suggesting the word "wet," has given rise to the belief that their utterance was a sign of a coming shower or storm. It is often by such illogical methods that these sayings have become established. After a few repetitions they become fixed in the mind and their origin forgotten; they are invested with an importance not their due, and not attributed to them by their originators. Ultimately they are incorporated in the weather-lore of the country.

Of the innumerable swallows, it is said, with as little show of reason:

> "No rain e'er poured upon the earth,
> That damped the twittering swallow's mirth."

No? Well, of late, the whole host takes refuge from storms—the barn-swallows in the hay-mow, the cliff-swallows under the eaves, the sand-martins in their burrows, and the chimney-swifts in their sooty homes in the chimneys. Why this change of habit? For a wonderful change must have taken place, if the couplet quoted was ever true. I do admit that swallows and swifts appear to be noisier before and during a shower; but does not this arise from the fact that at such a time they collect in great numbers near their nests, to take refuge, if the storm should increase in violence? And again, the silence of other birds makes the twittering swallow a more prominent bird than under other circumstances; but nothing of this warrants the extravagant assertion that no storm ever put a quietus upon them.

The larger hawks, too, are supposed to give warning of a coming shower when they utter their peculiar cat-like scream. Among our old people the following may sometimes be heard repeated:

> "The hen-hawk's scream, at hot, high noon,
> Foretells a coming shower soon."

This couplet is of some interest, as, at present, it is not applicable to our larger hawks and buzzards. Indeed, the only one of them that is prone to cry out while circling overhead is the red-tailed buzzard or hen-hawk, and this bird is very seldom seen in midsummer, and now certainly is only heard in autumn, winter, or early spring. The saying implies that formerly these birds were abundant at all times of the year, and during the summer would cry out in their peculiar fashion. The settlement of the country and general deforesting of such a large portion of it have driven these hawks to more retired parts during the nesting-season, and there, throughout summer, their cry may indicate that it will soon rain; but, if so, why does not the same cry in autumn have some reference to the weather?

It is scarcely necessary to continue the list. Other birds than those mentioned—reptiles, batrachians, and fishes—have all given rise to certain current sayings, but of no more value than those I have given, and all, I think, based upon illogical inferences. Snakes are claimed as excellent barometers; but the habits upon which the belief rests are those that characterize every day of the creature's life. Toads and frogs are largely depended upon, but a careful record for a single season will show how little they are to be trusted; and even the fishes can not disport themselves in summer, but straightway the clouds must open upon us, a tornado visit us, or premature frosts balk the calculations of the farmer.

Curiously enough, I do not find that insect-life has entered to any important extent into the weather-lore of this neighborhood. Contradictory remarks are often made as to ant-hills: thus, when they are very high, it will be a dry day; others insist that it is evidence that it will soon rain. Spiders' webs, also, are variously held as of barometric value; but a careful record of several summers contradicts this emphatically. The positions of the paper-hornets' nests, which in autumn are often prominent objects in the country, after the foliage drops, are variously asserted to be indicative of a "hard" or "open" winter, as they chance to be placed in the upper or lower branches of a tree. My skepticism as to the value of this sign arises from the fact that there is, as might be expected, no uniformity in the positions of any half-dozen such nests.

It may be rash to say that meteorological science can gain nothing from scientific observation of animal life; but the character of the weather-lore that has been handed down from father to son for the past two centuries plainly indicates that the observations which gave rise to them were anything but scientific in character. Mankind now, as formerly, may be close observers of Nature, but this does not imply that they are accurate observers. They assume as correct the appearance, but it is no unusual circumstance for an animal to be doing the very opposite of what might naturally be supposed was the case. The simple and sad fact derived from a study of local animal weather-lore is that, in the days of our grandfathers, painstaking naturalists were few and far between.

JAPANESE HOUSE-BUILDING.*

By Professor EDWARD S. MORSE.

THE first sight of a Japanese house—that is, a house of the people—is certainly disappointing. From the infinite variety and charming character of their various works of art, as we had seen them at home, we were anticipating new delights and surprises in the character of the house; nor were we on more intimate acquaintance to be disappointed. As an American, familiar with houses of certain types, with conditions among them signifying poverty and shiftlessness, and other conditions signifying refinement and wealth, we were not competent to judge the relative merits of a Japanese house.

The first sight, then, of a Japanese house is disappointing; it is unsubstantial in appearance, and there is a meagerness of color. Being unpainted, it suggests poverty; and this absence of paint, with the gray and often rain-stained color of the boards, leads one to compare it with similar unpainted buildings at home—and these are usually barns and sheds in the country, and the houses of the poorer people in the city. With one's eye accustomed to the bright contrasts of American houses, with their white, or light, painted surfaces; rectangular windows, black from the shadows within, with glints of light reflected from the glass; front door with its pretentious steps and portico; warm red chimneys surmounting all, and a general trimness of appearance outside, which is by no means always correlated with like conditions within—one is too apt at the outset to form a low estimate of a Japanese house. An American finds it difficult indeed to

* From "Japanese Homes and their Surroundings." By Edward S. Morse, Director of the Peabody Academy of Science; late Professor of Zoölogy, University of Tokio, Japan; Member of the National Academy of Science; Fellow of the American Academy of Arts and Sciences, etc. With Illustrations by the Author. Boston: Ticknor & Co. 1886.

consider such a structure as a dwelling, when so many features are absent that go to make up a dwelling at home—no doors or windows such as he had been familiar with; no attic or cellar; no chimneys, and within no fireplace, and of course no customary mantel; no permanently inclosed rooms; and, as for furniture, no beds or tables, chairs or similar articles—at least, so it appears at first sight.

One of the chief points of difference in a Japanese house, as compared with ours, lies in the treatment of partitions and outside walls. In our houses these are solid and permanent, and, when the frame is built, the partitions form part of the framework. In the Japanese house, on the contrary, there are two or more sides that have no permanent walls. Within, also, there are but few partitions which have similar stability; in their stead are slight sliding-screens, which run in appropriate grooves in the floor and overhead. These grooves mark the limit of each room. The screens may be opened by sliding them back, or they may be entirely removed, thus throwing a number of rooms into one great apartment. In the same way the whole side of a house may be flung open to sunlight and air. For communication between the rooms, therefore, swinging-doors are not necessary. As a substitute for windows, the outside screens, or *shōji*, are covered with white paper, allowing the light to be diffused through the house.

Where external walls appear they are of wood unpainted, or painted black, and, if of plaster, white or dark slate-colored. In certain classes of building the outside wall, to a height of several feet from the ground, and sometimes even the entire wall, may be tiled, the interspaces being pointed with white plaster. The roof may be either lightly shingled, heavily tiled, or thickly thatched. It has a moderate pitch, and, as a general thing, the slope is not so steep as in our roofs. Nearly all the houses have a veranda, which is protected by the widely overhanging eaves of the roof, or by a light supplementary roof projecting from beneath the eaves.

While most houses of the better class have a definite porch and vestibule, or *genka*, in houses of the poorer class this entrance is not separate from the living-room; and, since the interior of the house is accessible from two or three sides, one may enter it from any point. The floor is raised a foot and a half or more from the ground, and is covered with thick straw mats, rectangular in shape, of uniform size, with sharp, square edges, and so closely fitted that the floor upon which they rest is completely hidden. The rooms are either square or rectangular, and are made with absolute reference to the number of mats they are to contain. With the exception of the guest-room, few rooms have projections or bays. In the guest-room there is at one side a more or less deep recess divided into two bays by a slight partition; the one nearest the veranda is called the *tokonoma*. In this place hang one or more pictures, and upon its floor, which is slightly raised above the mats, rests a flower-vase, incense-burner, or some other object. The companion bay has shelves and a low closet. Other rooms also may have recesses to accommodate a case of drawers or shelves. Where closets and cupboards occur, they are finished with sliding screens instead of swinging-doors. In tea-houses of two stories the stairs, which often ascend from the vicinity of the kitchen, have beneath them a closet, and this is usually closed by a swinging-door.

In city houses the kitchen is at one side or corner of the house, generally in an L, covered with a pent-roof. This apartment is often toward the street, its yard separated from other areas by a high fence. In the country the kitchen is nearly always under the main roof. In the city few out-buildings, such as sheds and barns, are seen. Accom-

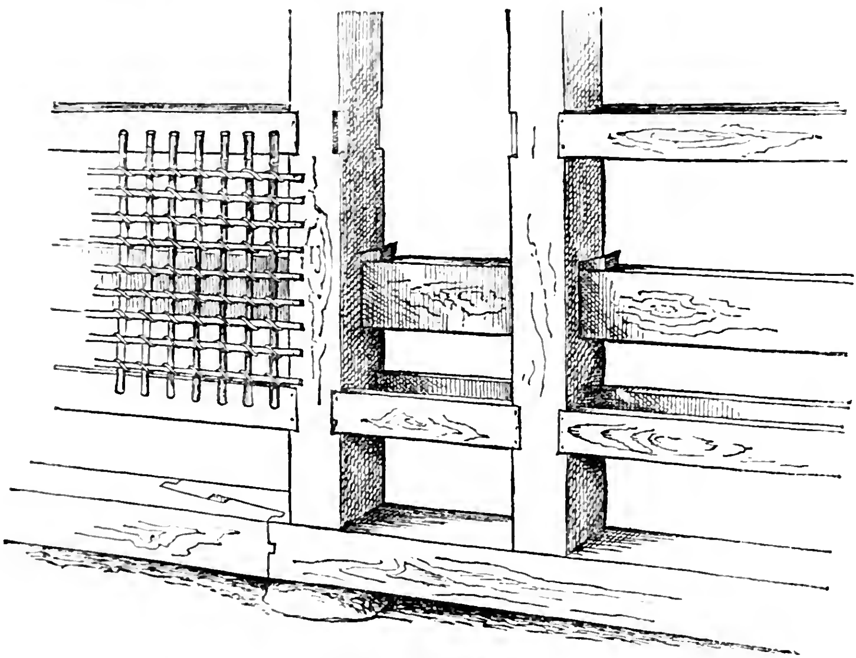

FIG. 1.—SIDE-FRAMING.

panying the houses of the better class are solid, thick-walled, one or two storied, fire-proof buildings called *kura*, in which the goods and chattels are stored away at the time of a conflagration. These buildings, which are known to the foreigners as "godowns," have one or two small windows and one door, closed by thick and ponderous shutters. Such a building usually stands isolated from the dwelling, though often in juxtaposition; and sometimes, though rarely, it is used as a domicile.

In the gardens of the better classes summer-houses and shelters of rustic appearance and diminutive proportions are often seen. Rustic arbors are also to be seen in the larger gardens. Specially constructed houses of quaint design and small size are not uncommon; in these the ceremonial tea-parties take place. High fences, either of board or bamboo, or solid walls of mud or tile with stone foundations, surround the house or inclose it from the street. Low rustic fences border the gardens in the suburbs. Gateways of various styles, some of imposing design, form the entrances; as a general thing they are either rustic and light, or formal and massive.

Whatever is commonplace in the appearance of the house is toward the street, while the artistic and picturesque face is turned toward the garden, which may be at one side or in the rear of the house—usually in the rear. Within these plain and unpretentious houses there are often to be seen marvels of exquisite carving and the perfection of cabinet-work; and surprise follows surprise as one becomes more fully acquainted with the interior finish of these curious and remarkable dwellings.

The framework of an ordinary Japanese dwelling is simple and primitive in structure; it consists of a number of upright beams which run from the ground to the transverse beams and inclines of the roof above. The vertical framing is held together either by short strips, which are let into appropriate notches in the uprights to which the bamboo lathing is fixed, or by longer strips of wood, which pass

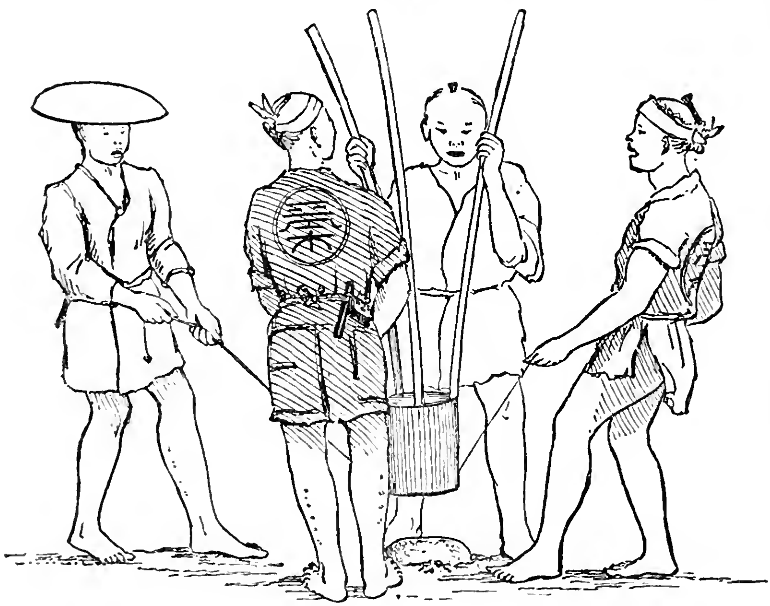

Fig. 2.—Pounding down Foundation-Stones.

through mortises in the uprights, and are firmly keyed or pinned into place (Fig. 1). In larger houses these uprights are held in position by a framework near the ground. There is no cellar or excavation beneath the house, nor is there a continuous stone foundation as with us. The uprights rest directly, and without attachment, upon single uncut or rough-hewed stones, these in turn resting upon others, which have been solidly pounded into the earth by means of a huge wooden maul worked by a number of men (Fig. 2). In this way the house is perched upon these stones, with the floor elevated at least a foot and a half or two feet above the ground. In some cases the space between the uprights is boarded up; this is generally seen in Kioto houses. In others the wind has free play beneath; and, while this exposed condition renders the house much colder and more uncomfortable in winter, the inmates are never troubled by the noisome air of the cellar, which too often infects our houses at home. Closed wooden fences of a more solid character are elevated in this way; that is, the lower rail or sill of the fence rests directly upon stones placed at intervals apart of six or eight feet. The ravages of numerous ground-insects, as well as larvæ, and the excessive dampness of the ground at certain seasons of the year, render this method of building a necessity.

The accurate way in which the base of the uprights is wrought to fit the inequalities of the stones upon which they rest is worthy of notice. In the emperor's garden we saw a two-storied house finished in the most simple and exquisite manner. It was, indeed, like a beautiful cabinet, though disfigured by a bright-colored foreign carpet upon its lower floor. The uprights of this structure rested on large, oval, beach-worn stones buried endwise in the ground; and, upon the smooth rounded portions of the stones, which projected above the level of the ground to a height of ten inches or more, the uprights had been most accurately fitted (Fig. 3). The effect was extremely light and buoyant, though apparently insecure to the last degree; yet this building had not only withstood a number of earthquake-shocks, but also the strain of severe typhoons, which during the summer months sweep over Japan with such violence. If the building be very small, then the frame consists of four corner-posts running to the roof. In dwellings having a frontage of two or more rooms, other uprights occur between the corner-posts. As the rooms increase in number through the house, uprights come in the corners of the rooms, against which the sliding-screens, or *fusuma*, abut. The passage of these uprights through the room to the roof above gives a solid constructive appearance to the house. When a house has a veranda—and nearly every

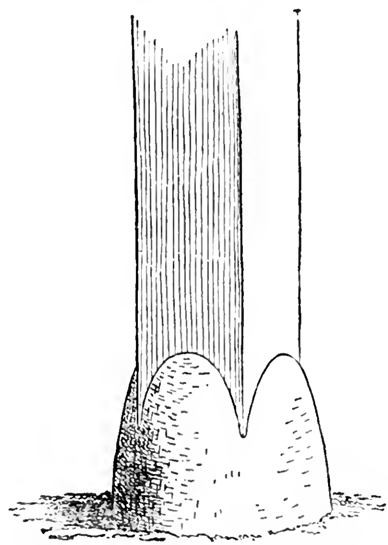

Fig. 3.—Foundation-Stone.

house possesses this feature on one or more of its sides—another row of uprights starts in a line with the outer edge of the veranda. Unless the veranda be very long, an upright at each end is sufficient to support the supplementary roof which shelters it. These uprights support a cross-beam, upon which the slight rafters of the supplementary roof rest. This cross-beam is often a straight unhewed stick of timber, from which the bark has been removed. Indeed, most of the horizontal framing-timbers, as well as the rafters, are usually unhewed—the rafters often having the bark on, or perhaps being accurately squared sticks; but, in either case, they are always visible as they project from the sides of the house, and run out to support the overhanging eaves. The larger beams and girders are but slightly hewed; and it is not unusual to see irregular-shaped beams worked into the construction of a frame, often for their quaint effects (Fig. 4), and in many cases as a matter of economy.

For a narrow house, if the roof be a gable, a central upright at each end of the building gives support to the ridge-pole from which

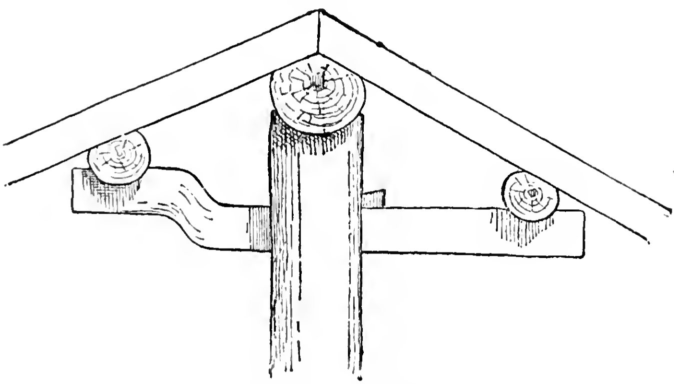

Fig. 4.—Section of Framing.

the rafters run to the eaves. If the building be wide, a transverse beam traverses the end of the building on a level with the eaves, supported at intervals by uprights from the ground; and upon this short uprights rest, supporting another transverse beam above, and often three or more tiers are carried nearly to the ridge. Upon these supports rest the horizontal beams which run parallel with the ridge-pole, and which are intended to give support to the rafters (Fig. 5).

In the case of a wide gable-roof there are many ways to support the frame, one of which is illustrated in the following outline (Fig. 6). Here a stout stick of timber runs from one end of the house to the other on a vertical line with the ridge-pole, and on a level with the eaves. This stick is always crowning, in order to give additional strength. A few thick uprights start from this to support the ridge-pole above; from these uprights beams run to the eaves; these are mortised into the uprights, but at different levels on either side, in order not to weaken the uprights by the mortises. From these beams run short supports to the horizontal rafters above.

The roof, if it be of tile or thatch, represents a massive weight—the tiles being thick and quite heavy, and always bedded in a thick

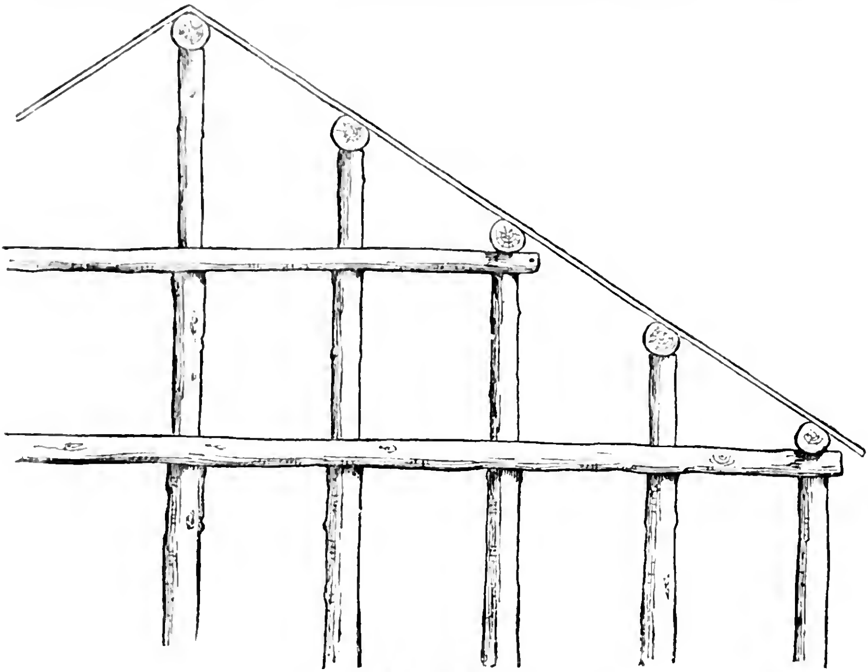

Fig. 5.—End-Framing of Large Building.

layer of mud. The thatch, though not so heavy, often becomes so after a long rain. The roof-framing, consequently, has oftentimes to support a great weight; and, though in its structure looking weak, or at least primitive in design, yet experience must have taught the Japanese carpenters that their methods were not only the simplest and

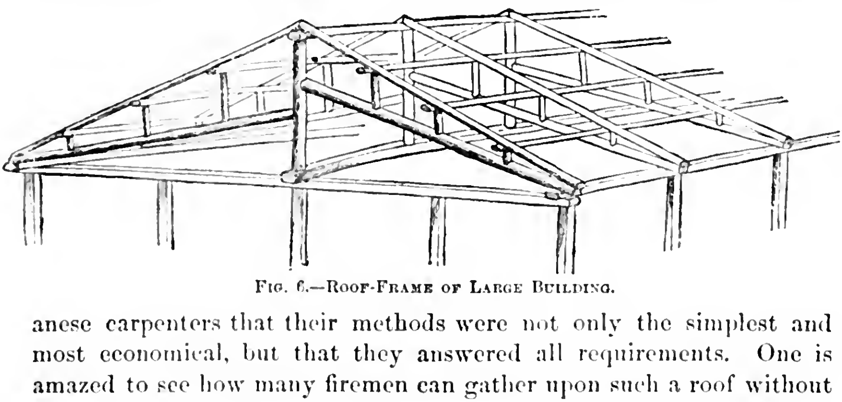

Fig. 6.—Roof-Frame of Large Building.

most economical, but that they answered all requirements. One is amazed to see how many firemen can gather upon such a roof without its yielding. I have seen massive house-roofs over two hundred years old, and other frame structures of a larger size and of far greater age, which presented no visible signs of weakness. Indeed, it is a very unusual sight to see a broken-backed roof in Japan.

Diagonal bracing in the framework of a building is never seen. Sometimes, however, the uprights in a weak frame are supported by braces running from the ground at an acute angle, and held in place by wooden pins. Outside diagonal braces are sometimes met with as an ornamental feature. In the province of Ise one often sees a brace or bracket made out of an unhewed piece of timber, generally the proximal portion of some big branch. This is fastened to an upright, and appears to be a brace to hold up the end of a horizontal beam that projects beyond the eaves. These braces, however, are not even notched into the upright, but held in place by square wooden pins, and are of little use as a support for the building, though answering well to hold fishing-rods and other long poles, which find here convenient lodgment (Fig. 7).

The framework of a building is often revealed in the room in a way that would delight the heart of an Eastlake. Irregularities in the form of a stick are not looked upon as a hindrance in the construction of a building. From the way such crooked beams are brought into use, one is led to believe that the builder prefers them. The desire for rustic effects leads to the selection of odd-shaped timber. Fig. 4 represents the end of a room, wherein is seen a crooked cross-piece passing through a central upright, which sustains the ridge-pole.

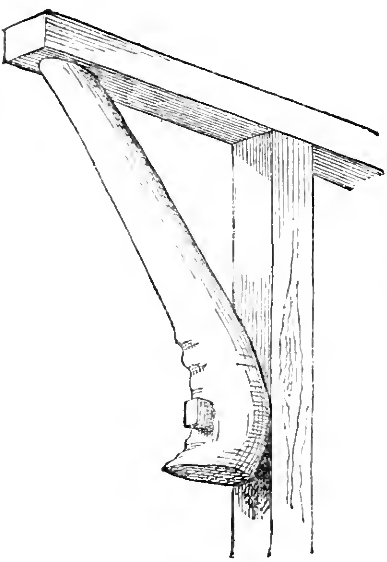

Fig. 7.—Outside Brace.

As the rooms are made in sizes corresponding to the number of mats they are to contain, the beams, uprights, rafters, flooring-boards, boards for the ceiling, and all strips are got out in sizes to accommodate these various dimensions. The dimensions of the mats from one end of the empire to the other are approximately three feet wide and six feet long; and these are fitted compactly on the floor. The architect marks on his plan the number of mats each room is to contain—this number defining the size of the room; hence, the lumber used must be of definite lengths, and the carpenter is sure to find these lengths at the lumber-yard. It follows from this that but little waste occurs in the construction of a Japanese house.

The permanent partitions within the house are made in various ways. In one method bamboo strips of various lengths take the place of laths. Small bamboos are first nailed in a vertical position to the wooden strips, which are fastened from one upright to another; narrow strips of bamboo are then secured across these bamboos by means of coarse cords of straw, or bark-fiber (Fig. 1). This partition is not unlike our own plaster-and-lath partition. Another kind of partition may be of boards; and against these small bamboo rods are nailed quite close together, and upon this the plaster is put. Considerable pains are taken as to the plastering. The plasterer brings to the house samples of various-colored sands and clays, so that one may select from these the color of his wall. A good coat of plaster comprises three layers. The first layer, called *shita-nuri*, is composed of mud, in which chopped straw is mixed; a second layer, called *chu-nuri*, of rough lime, mixed with mud; the third layer, called *uwa-nuri*, has the colored clay or sand mixed with lime—and this last layer is always applied by a skillful workman.

Many of the partitions between the rooms consist entirely of light sliding-screens. Often two or more sides of the house are composed entirely of these simple and frail devices. The outside permanent walls of a house, if of wood, are made of thin boards nailed to the frame horizontally—as we lay clapboards on our houses. These may be more firmly held to the house by long strips nailed against the boards vertically. The boards may also be secured to the house vertically, and weather-strips nailed over the seams—as is commonly the way with certain of our houses. In the southern provinces a rough house-wall is made of wide slabs of bark, placed vertically, and held in place by thin strips of bamboo nailed crosswise. This style is common among the poorer houses in Japan; and, indeed, in the better class of houses it is often used as an ornamental feature, placed at the height of a few feet from the ground.

Outside plastered walls are also very common, though not of a durable nature. This kind of wall is frequently seen in a dilapidated condition. In Japanese picture-books this broken condition is often shown, with the bamboo slats exposed, as a suggestion of poverty.

In the cities the outside walls of more durable structures, such as warehouses, are not infrequently covered with square tiles, a board wall being first made, to which the tiles are secured by being nailed at their corners. These may be placed in diagonal or horizontal rows—in either case an interspace of a quarter of an inch being left between the tiles, and the seams closed with white plaster, spreading on each side to the width of an inch or more, and finished with a rounded surface. This work is done in a very tasteful and artistic manner, and the effect of the dark-gray tiles crossed by these white bars of plaster is very striking (Fig. 8).

The Japanese dwellings are always of wood, usually of one story and unpainted. Rarely does a house strike one as being specially marked or better looking than its neighbors; more substantial, certainly, some of them are, and yet there is a sameness about them which becomes wearisome. Particularly is this the case with the long, uninteresting row of houses that border a village street; their picturesque

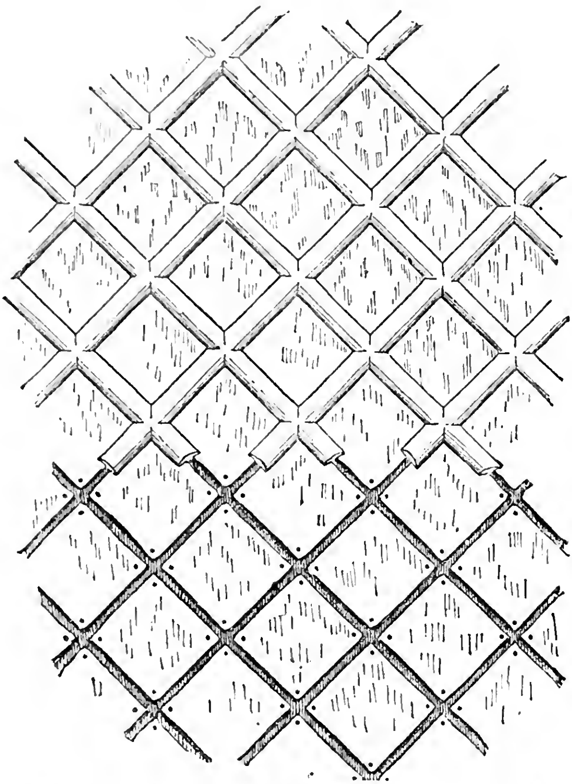

FIG. 8.—ARRANGEMENT OF SQUARE TILES ON SIDE OF HOUSE.

roofs alone save them from becoming monotonous. A closer study, however, reveals some marked differences between the country and city houses, as well as between those of different provinces.

The country house, if anything more than a shelter from the elements, is larger and more substantial than the city house, and, with its ponderous thatched roof and elaborate ridge, is always picturesque. One sees much larger houses in the north—roofs of grand proportions and an amplitude of space beneath, that farther south occurs only under the roofs of temples. We speak now of the houses of the better classes, for the poor farm-laborer and fisherman, as well as their prototypes in the city, possess houses that are little better than shanties, built, as a friend has forcibly expressed it, of "chips, paper, and straw." But even these huts, clustered together as they oftentimes are in the larger cities, are palatial in contrast to the shattered and filthy condition of a like class of tenements in many of the cities of Christian countries.

In traveling through the country the absence of a middle class, as indicated by the dwellings, is painfully apparent. It is true that you

Fig. 9.—Street in Kanda Ku, Tokio.

pass, now and then, large comfortable houses with their broad thatched roofs, showing evidences of wealth and abundance in the numerous *kura* and out-buildings surrounding them ; but, where you find one of these, you pass hundreds which are barely more than shelters for their

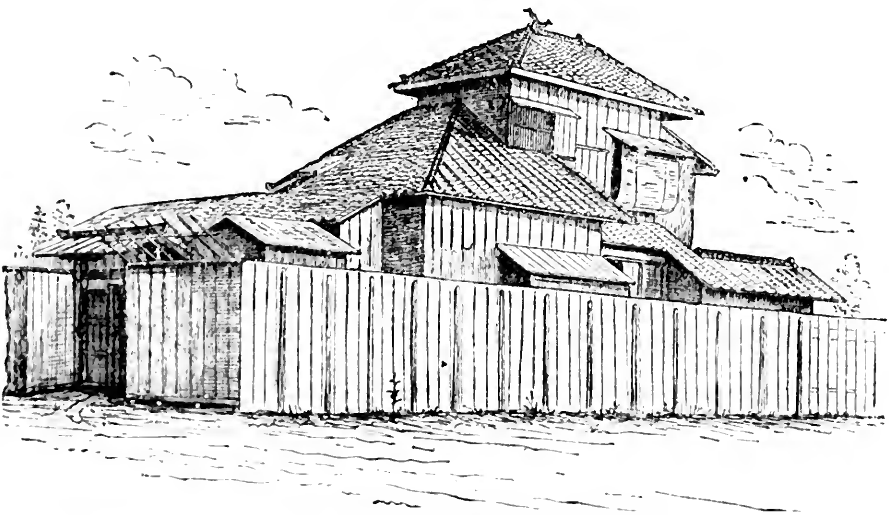

Fig. 10.—Street View of Dwelling in Tokio.

inmates, and, within the few necessary articles render the evidences of poverty all the more apparent.

Though the people that inhabit such shelters are very poor, they appear contented and cheerful notwithstanding their poverty. Other classes, who, though not poverty-stricken, are yet poor in every sense of the word, occupy dwellings of the simplest character. Many of the dwellings are often diminutive in size; and, as one looks in at a tiny cottage containing two or three rooms at the most, the entire house hardly bigger than a good-sized room at home, and observes a family of three or four persons living quietly and in a cleanly manner in this limited space, he learns that in Japan, at least, poverty and constricted quarters are not always correlated with coarse manners, filth, and crime.

The accompanying sketch (Fig. 9) represents a group of houses bordering a street in Kanda Ku, Tokio. The windows are in some cases projecting or hanging bays, and are barred with bamboo or square bars of wood. A sliding-screen, covered with stout white paper, takes the place of our glass-windows. Through these gratings the inmates of the house do their bargaining with the street venders. The entrance to these houses is usually by means of a gate common to a number. This entrance consists of a large gate used for vehicles and heavy loads, and by the side of this is a smaller gate used by the people. Sometimes the big gate has a large square opening in it, closed by a sliding-door or grating—and through this the inmates have ingress and egress.

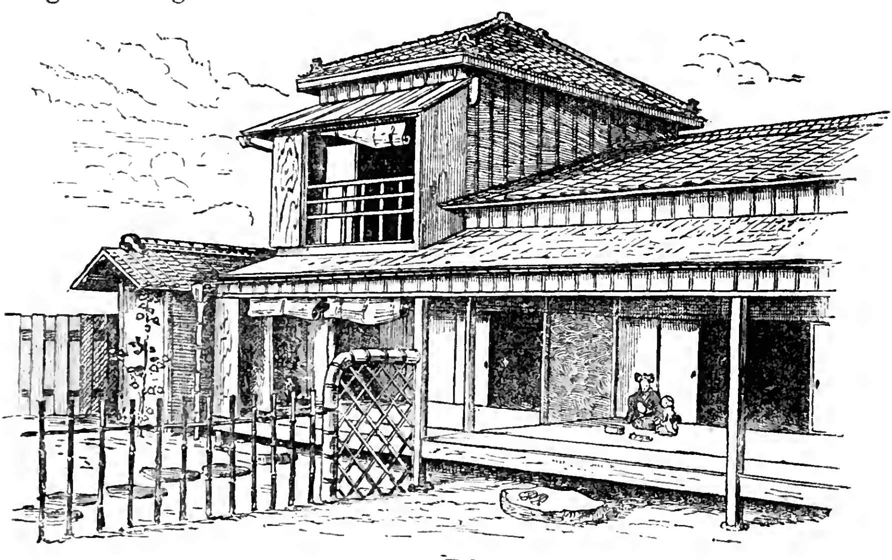

Fig. 11.—View of Dwelling from Garden, in Tokio.

The houses, if of wood, are painted black; or else, as is more usually the case, the wood is left in its natural state, and this gradually turns to a darker shade by exposure. When painted, a dead black is used; and this color is certainly agreeable to the eyes, though the heat-rays caused by this black surface become almost unendurable on hot days, and must add greatly to the heat and discomfort within the house. With a plastered outside wall the surface is often left white, while the framework of the building is painted black—and this treatment gives it a decidedly funereal aspect.

The sketch shown in Fig. 10 is a city house of one of the better classes. The house stands on a new street, and the lot on one side is vacant; nevertheless, the house is surrounded on all sides by a high board-fence—since, with the open character of a Japanese house, privacy, if desired, can be secured only by high fences or thick hedges. The house is shown as it appears from the street. The front door is near the gate, which is shown on the left of the sketch. There is here no display of an architectural front; indeed, there is no display anywhere. The largest and best rooms are in the back of the house; and what might be called a back-yard, upon which the kitchen opens, is parallel with the area in front of the main entrance to the house, and separated from it by a high fence. The second story contains one room, and this may be regarded as a guest-chamber. Access to this chamber is by means of a steep flight of steps, made out of thick plank, and unguarded by hand-rail of any kind. The roof is heavily tiled, while the walls of the house are outwardly composed of broad thin boards, put on vertically, and having strips of wood to cover the joints. A back view of this house is shown in Fig. 11. Here all the rooms open

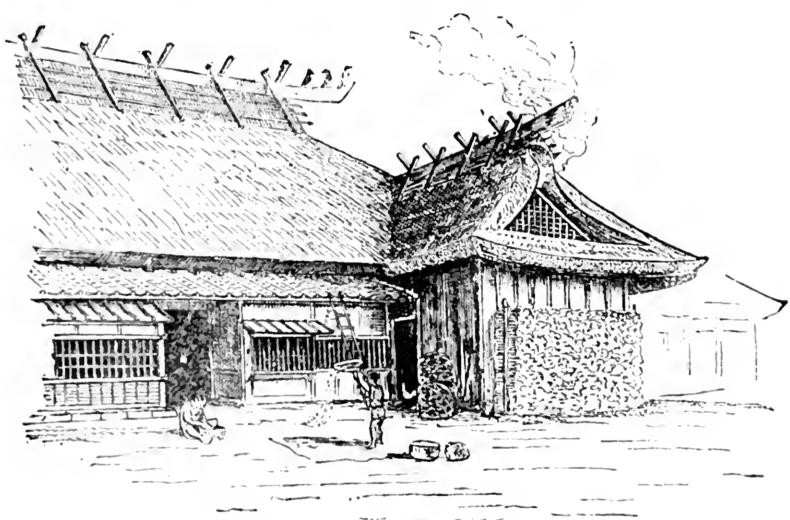

Fig. 12.—Old Farm-House in Kabutoyama.

directly on the garden. Along the veranda are three rooms *en suite*. The balcony of the second story is covered by a light supplementary roof, from which hangs a bamboo screen to shade the room from the sun's rays. Similar screens are also seen hanging below.

The veranda is quite spacious; and in line with the division between the rooms is a groove for the adjustment of a wooden screen or shutter when it is desired to separate the house into two portions temporarily. At the end of the veranda, to the left of the sketch, is the latrine. The house is quite open beneath, and the air has free circulation.

The country house of an independent *samurai*, or rich farmer, is large, roomy, and thoroughly comfortable. I recall with the keenest pleasure the delightful days enjoyed under the roof of one of these typical mansions in Kabutoyama, in the western part of the province of Musashi. The residence consisted of a group of buildings shut in from the road by a high wall. Passing through a ponderous gateway, one enters a spacious court-yard, flanked on either side by long, low buildings, used as store-houses and servants' quarters. At the farther end of the yard, and facing the entrance, was a comfortable old farm-house, having a projecting gable-wing to its right (Fig. 12). The roof was a thatched one of unusual thickness. At the end of the wing was a triangular latticed opening, from which thin blue wreaths of smoke were curling. This building contained a few rooms, including an unusually spacious kitchen. The kitchen opened directly into a larger and unfinished portion of the house, having the earth for its floor, and used as a wood-shed. The owner informed me that the farm-house was nearly three hundred years old. To the left of the building was a high wooden fence, and, passing through a gateway, one came into a smaller yard and garden. In this area was another house quite independent of the farm-house; this was the house for guests. Its conspicuous feature consisted of a newly-thatched roof, surmounted by an elaborate and picturesque ridge—its design derived from temple architecture. Within were two large rooms opening upon a narrow veranda. These rooms were unusually high in stud, and the mats and all the appointments were most scrupulously clean. Communication with the old house was by means of a covered passage. Back of this dwelling, and some distance from it, was still another house, two stories in height, and built in the most perfect taste; and here lived the grandfather of the family—a fine old gentleman, dignified and courtly in his manners.

THE INFLUENCE OF INVENTIONS UPON CIVILIZATION.

By CHAUNCEY SMITH.

[*Concluded.*]

THE relation between astronomical and mathematical investigations and navigation has been long recognized, but this relation is dependent upon the observation of the apparent position of heavenly bodies at given times, and these observations are in turn dependent upon telescopes and upon clocks and chronometers, both modern inventions.

The working of the railroads of the country is hardly less dependent upon the time-keepers we possess than navigation is upon chronometers. Let any one ask himself how the railroads of this country could be operated if our only time-keepers were sun-dials, hour-glasses, and the clepsydras of the ancients, and he will soon see that the construction of the time-tables of our railroads and the operation of the roads in conformity with them would be impossible.

Mr. Atkinson will tell us what it costs to transport a barrel of flour upon our railroads from Minneapolis to Boston, and approximately what the saving is by the railroads over the old modes of transportation, but can he tell us what part of that saving is to be credited to the clocks at the railroad-stations and to the watches which the conductors carry in their pockets?

The late Judge Curtis said to me several years ago that the introduction of railroads had made a great change in the habits of the people as to punctuality in keeping appointments; that before their introduction nobody thought of being punctual to a minute, or even to an hour. Nobody thought of being "on time" till the railroads presented the alternative of being so or of "getting left."

One can now easily see that before the general use of clocks and watches, punctuality, as it is now understood among business-men, could hardly have been reckoned as a duty. This is one illustration out of many more important ones where our social or moral obligations have arisen from or have been changed by physical inventions. By observations upon the laws or conditions of health by means of recent inventions and only possible by their means, we have learned how to counteract or prevent the introduction or spread of many diseases, and in consequence of this, men recognize the duty to adopt and enforce many regulations in society for which no reason could be found a few years ago.

How could we live without glass? It enters so largely into the list of things we consider absolutely necessary, to say nothing of its uses for convenience or luxury, that we should almost as soon think of living without light or heat, without air or water, as to live without this cheap substance made principally out of the sand under our feet. Can any one tell what civilization would be without it? It would certainly be a very different thing from what it is.

We talk of the fireside and the influence it has upon families and social life, but the window plays a more important part in our homes than the fireside. The invention of glass goes back to a very early period, but its general use for windows is comparatively recent. Accustomed as we are to glass windows, it is difficult for us to conceive how a house could be lived in with comfort without it.

There is another use of glass, resting upon a very simple invention, which plays a very important part in the comfort of man and the value of his labor, and which contributes wonderfully to our knowledge of nature and the universe.

Ever since man was capable of observing things around him, he must often have seen that a straight stick thrust obliquely into the water appeared to be bent at its surface. It was a long time before man learned the value of this fact; but at length the lens was discovered. The invention consisted simply in the form given to a piece of glass; in giving to one or both of the surfaces of a disk of glass a curved form. This we know forms a lens, and a lens has become one of the most valuable devices known to man, but it was a long time after its invention before it became of much value.

A thousand years elapsed after the invention of the lens before it assumed an important place among the instruments employed by man. But man learned its value at last. Lenses may be made of other materials than glass, but for all practical purposes they are made of glass, and no other material will supply its place.

I alluded to spectacles as a valuable invention. I have never seen any attempt to estimate its value. I do not know that I ever heard the inquiry made. And yet when we remember that nearly every person above the age of forty-five, and very many below that age, use glasses, we see that they must enter largely into the sum of our comforts. How many persons would be deprived of the pleasures and benefits of reading and writing during a large portion of their lives but for this simple invention! How many kinds of labor would be performed badly and with great discomfort but for these devices! At what disadvantage literary labor would be carried on without them! For how many delicate handicrafts would men and women become unfitted in their later years but for them! At what discomfort and inconvenience would domestic needlework be performed in their absence! How much trial of the patience is saved by their use! I doubt not our tempers are much better in old age for these helps.

But the value of the invention of the lens is not limited to its use for spectacles. From it has grown up those wonderful modern instruments, the telescope and microscope. Through the former has come a large part of our astronomical knowledge, which has a great commercial value from the security it gives to man in navigating the oceans. It has also a high moral and mental value from the field it opens to the exercise and training of the powers of observation and imagination; from the new conceptions it has given us of the immensity of creation, and of the power which gave it birth. I wonder if any man can rise from a contemplation of the facts, the mysteries, and magnitudes of the universe, revealed to us by the telescope and spectroscope, without repeating to himself, with a new sense of its significance, the question, "What is man that Thou art mindful of him, or the son of man that Thou visitest him?"

But, while the lens thus opens up to man in the boundless regions of space a universe which no stretch of the imagination could give him a glimpse of without it, it opens up to him also a no less wonderful universe in regions which, by reason of their littleness, lie equally beyond his powers of observation or the powers of his imagination.

It reveals to him the presence of life in forms as wonderful for their minuteness and activity and numbers as the sun and stars are for the mighty spaces they occupy and traverse.

This little device, then, of a piece of glass formed with curved surfaces, which a boy may fashion upon a piece of sandstone, not only enters into the daily use of man, ministering to his comfort and prolonging his power to work efficiently, but in no figurative sense it enables him to behold a new heaven and a new earth. It opens to him the most wonderful secrets of nature, and gives him new conceptions of the vastness of the universe and of the magnitude of the forces involved in its mechanism. The ancients believed that the sun was only a few miles away, a few thousand miles at most, but the telescope has enabled man to learn that the sun is 92,000,000 miles away from us; that the earth, 8,000 miles in diameter, in his yearly journey around it, travels 600,000,000 miles, at the rate of nearly twenty miles a second.

What conception of infinite power could the imagination, unaided, give to man, which could in the least approach that which is involved in this movement of the earth!

But we know through the telescope, that this power, mighty as it is, is but an infinitesimal part of that which is actually displayed in the regions of space which only within recent years and by the aid of a multitude of inventions have been opened to the observation of man.

Upon glass and the lens man is dependent for the use of another recent invention, which now that we have it we would not willingly do without.

A beautiful art has come into existence since I was a young man, which gratifies one of the strongest desires of the heart and ministers to the social pleasures of every family and circle of friends. I well remember when the newspaper first announced that a Frenchman had invented a way of taking pictures by the help of the sun. Before that time very few people could have likenesses of their friends, living or dead. The face of a friend could only be seen when he was present. When absent, memory must do what it could to preserve the features. Only the rich, and not a large proportion of them, could command portraits of themselves or friends. Into what houses will you now go where you do not expect to find likenesses of whole families, and whole circles of friends? Very poor indeed are those who can not and do not find the means of procuring and preserving pictures of those they love. Can any one measure the amount of gratification which the world has received from the practice of the wonderful art of taking pictures from nature, through the agency of a few chemicals spread upon a sheet of paper or of silver, and of the rays of light concentrated by means of a lens? There has been received from it mental, artistic, and moral culture. The invention has opened up a new field of investigation and research to the labor of the chemist and to the student of nature. From the first announcement to the world, to the present hour, a host of inventors have been engaged in perfecting and improving the art, enlarging the field of its applications, and studying the laws of nature upon which it rests. The boundaries of human knowledge, in more than one department of physics, have been greatly extended in these efforts. Astronomy has received important aid from it, and by its help we get not merely pictures of what exists in the heavenly regions, but records of what is there taking place.

This art has even come to play an important part in the administration of justice and in the protection of the community against crime. By its aid criminals are detected, watched, and convicted. Forgeries are proved or disproved by its use. It finds an important place in the ordinary business of commerce and the mechanic arts. By its aid, copies or representations of all valuable works of art are placed within the reach of multitudes who, otherwise, would know nothing of them or know them only through inadequate verbal description. The improvement of the public taste in relation to art, by the knowledge of works of art which has been thus diffused, has been very great.

Does any one doubt that this extension and this spread of knowledge of the works of art must tend to the improvement of man's moral nature? Can it be doubted that the social affections are quickened by the preservation of the features of friends and the interchange among friends and families of pictures of those who make up the family circle? Will not a boy, absent from home, feel the influence of home more strongly when he looks upon the faces of parents or sisters, than he would if he could not thus bring them into his presence?

But all these benefits which the world reaps from photography have come to us from inventions. It is not the fruit so much of genius, as of that patient labor and research which is winning from Nature, day by day, secrets far more valuable to man than all her hidden treasures of gold and silver.

Within the memory of men not very old, a new power has, by the genius of inventors, been trained into the service of man. This power is electricity. It has always, as we now know, been present in many of the phenomena of nature, exhibiting itself most strikingly in the lightnings of the thunder-storm, revealing, as man believed, the presence of a mysterious power which might be destructive, but which never could be useful to man.

A trifling incident revealed to an observing man in Italy the fact that, when two metals and the leg of a frog were made to touch, the muscles of the leg were contracted. This was a little more than a hundred years ago. This led to the invention of the galvanic battery, an instrument by which man was enabled to generate electricity for his own use. But many years were still to elapse before man could turn the instrument to much service.

Forty years later, another observer noticed that, when a wire which was carrying a current of electricity generated by a battery was placed near the needle of a compass, it turned the needle one way or the other on its pivot. A few years later, Faraday discovered that if such a wire was wound around a piece of soft iron, it made a magnet of the iron. Out of these simple facts have arisen the inventions of the telegraph, the telephone, and the electric light. The oldest of these inventions, the telegraph, is only about forty-five years old, and there are many who can easily remember the feelings of incredulity and amazement with which the claim that the invention had been made was received.

Can any one calculate the influence which this invention is destined to have upon the condition of man? We think it has spread over the world with wonderful rapidity. And so it has. But the world has just begun to use it. Although we see telegraph lines spread all over this country, and we say and think that everybody uses the telegraph, yet the number of messages sent last year did not much exceed one to each two persons in the land, while the number of letters written, including postal-cards, probably exceeded ten to each individual. When messages can be sent, as they most certainly will be, to any part of the land for ten cents or less, multitudes of people, who never think now of using the telegraph except upon matters of pressing importance, will use it upon the most common occasions. How many times would the simple "all well" be exchanged daily between friends if it could be done for five or ten cents!

A multitude of inventors have been necessary to make the telegraph what it is, and its improvement was never going on more rapidly than to-day. I well remember how difficult it was for many persons to form an idea, when the telegraph was first invented, of the way it worked. It was not an uncommon belief that the paper on which the message was written was in some way sent along the wire to its destination. But the idea became familiar after a little time that the electricity only traversed the line and operated a mechanism at the distant place which recorded the message in a new language, or delivered it directly to the ear, and people began to think that they understood how the telegraph was worked. But when inventors began to talk about sending two or three messages over the same wire, at the same time, the limit of belief seemed to have been reached, and people obstinately refused to believe that the thing could be done. But it has been done in more ways than one, and now there are numerous wires in the country over which four or even six messages are sent at the same time. As these inventions enable one wire to do the work of two or four or more, the wires which are wanting are called by the telegraph people "phantom-wires." The improvement of the telegraph is taking other directions. On the common lines the messages are sent by the operator at the rate of about thirty or forty words a minute. But inventions are in progress, and are now being introduced, which will enable a thousand words a minute to be sent. Think of sending messages from Boston to New York over one wire, and recording them there, at the rate of a thousand words a minute! Few people speak at the rate of two hundred words a minute.

Those of us who are in the habit of receiving messages, often get them printed on long strips of paper. The invention used in sending messages in that way is one which enables a man in New York, by touching keys like those of a piano, to operate a printing-machine in Boston or Chicago.

The highest achievements in telegraphy are undoubtedly reached in the ocean telegraph. It demanded a whole line of inventions peculiar to itself. A simple wire could not be used for a conductor. It would give out the electricity to the water so fast that none would reach the farther end to deliver the message, and the wire itself would be speedily destroyed. A coating must, therefore, be found for it which would at once protect the wire from the action of the water and keep the electricity from going off into the water. When such a coating had been invented, it was found necessary to strengthen the copper wire used for the conductor by the addition of steel wires, which must not touch the copper wire, but surround it, and this too must be protected by a coating. Then machinery had to be invented to combine the copper and steel wires with the coating material into a cable. Other machinery had to be invented to deliver the cable from a ship as she sailed over the course where the cable was to be laid. Only the steamship could be used for the purpose, and thus the invention of the steam-engine gave to man the power to establish ocean telegraphs. New instruments of the most wonderful sensibility had to be invented both for sending and receiving the messages. A minute magnet carries a tiny mirror and is suspended by a thread so as to yield to the slightest impulse. A ray of light from a lamp falls upon this mirror and is reflected upon a screen some feet distant. This ray of light is the finger which the operator watches upon the screen. As the current in the wire varies under the action of the sending instrument, the magnet turns one way or the other, and the spot of light on the screen moves one way or the other and indicates the signals of the Morse alphabet to the operator and enables him to spell out the words.

Sometimes a fault is developed in the wire as it lies on the bottom of the ocean, and signals can not be sent. Does it seem possible that man can tell whereabout on three thousand miles of wire, two miles under water, the fault is? He has invented instruments which enable him to do it, and to send a vessel to the very spot over the wire where the fault is, pick up the wire and mend it, and return it to its resting-place.

Some time before his death, in 1819, while resting from labor in his old age, James Watt, when asked to allow his fellow-citizens to honor him with a seat in Parliament, refused, saying that he had given employment to the better part of a million of men, and had earned the right to rest from work. To how many millions of men since then has his invention given employment! In a life of Watt published many years since I find a statement that the steam-power of the world was equal to that of 400,000,000 men, and this amount has probably been doubled since the statement was made. And yet the world has even now but just begun to reap the fruits of this invention. Each year witnesses the extension of its use.

About seventy years ago Robert Fulton, one of the greatest mechanical geniuses of this country, applied the steam-engine to a boat and made the first trial of a ship moved by the power of heat in a trip from New York to Albany. Now every ocean is plowed by the steamship, and there is hardly a navigable river on the face of the globe that has not become a highway for it. A few years later, in 1825, George Stephenson invented the locomotive and gave to man the railroad, and now, sixty years later, we have more than 128,000 miles of railroad in operation in this country alone.

I believe that no other Englishman has done so much for his fellow-men, so much to change the social and economical conditions of society, as George Stephenson.

Would you like to know how much the steam-engine has increased the power of man in Massachusetts? I can tell you what the locomotive has done. In 1878 the railroad companies of this State had 1,030 locomotives. The proportion due to the amount of their track in this State was 757, and the work they did was equal to what 913,545 horses could do on good common roads, and was equivalent to the labor of 5,481,270 laboring-men, or to that of a population of nearly 20,000,000.

Now, in 1875, Massachusetts had only about 130,000 horses, and her population was a little more than a million and a half.

But this was not all that Massachusetts owed to the steam-engine. She employs it largely in steam-vessels owned in the State or coming from abroad. What the whole amount of work done by these vessels was equal to I do not know, but it was large.

She also employed steam- and water-power in her manufactures equal to that of 1,912,488 men. The work done by the steam- and water-power was equal to what could have been done by hand-power by a population of 7,400,000.

I think there are more than 20,000 locomotives in the United States. There would be more than that if all the roads were as well provided with locomotives as the roads in Massachusetts are.

Assuming that to be the number, and that they do as much work as they do here, and the work is equal to that of 25,000,000 horses, or to that of nearly 150,000,000 men, or to a population of nearly 500,000,000. I suppose the actual population of the United States is nearly 60,000,000. We see by this how much in this country alone the inventions of Watt and Stephenson have increased the powers of man. The imagination staggers under the figures.

Of course a host of other inventors have been concerned with the results I have given, but the results are none the less the work of inventors because there are many of them.

The steam-engine has entered into many other inventions, the steam-drill and the steam-dredge, for instance, which have given to man the ability to execute engineering works of the most extraordinary character.

The steam-hammer is another of the wonders of modern machinery which followed the steam-engine. One of the gods of ancient mythology was Vulcan, a blacksmith, who was supposed, I believe, to have forged the thunderbolts of Jupiter. What conception may have been entertained of his power or of the magnitude of thunderbolts, I can not say, but probably he was never supposed to wield a hammer like a modern steam-hammer, weighing thirty-five tons, through a distance of ten or twelve feet, or to have executed any work like the forging of the propeller-shaft of a modern steamship. But what ancient gods could not do the modern inventor easily does.

The power of the steam-engine comes from heat—from the fire in the boiler. The fuel used is largely coal, stored ages ago in the earth. Fire has been long known to man and has been ready to do his work, and the iron and steel for engines had been long known. But not till the magic of the inventor had brought these things together did man learn what power was lying ready to his hand.

If at the time Watt made his improvement in the steam-engine some change in the laws of Nature had come into play which had gradually increased the physical power of man until now it had become tenfold greater than it was, this increase would not be equal to that which man has gained from the labors of Watt and the inventors who have succeeded him in the development of that instrument, and in the invention and improvement of machines to be used in connection with it. And this increased power of man is not exerted for the rich alone, but is shared by the great mass of men as impartially as if the power of each individual had been increased, as I have supposed, in the same ratio. We see this most strikingly in the ability which the railroad and the telegraph have given to the laboring-men in the mechanical industries throughout the land to combine and organize for mutual support, and in opposition, as it is said, to capital. It is only through the agency of the railroad and the telegraph that a great body of laboring-men scattered over a wide area of territory are able to organize and act as a unit, and thus secure the highest prices for their labor which the nature of their work and the demands of society will permit. It is only by reason of the capital of others invested in these recent inventions that laboring-men have acquired the power, which may be used either wisely or unwisely, to secure and exercise the strength which comes from union, and to deal with employers and capitalists on an equal footing, if not with the conditions in their favor.

Take another illustration:

One of the most simple transactions of our lives is to purchase a postal-card for one cent, write a communication on one side, and on the opposite side a direction to a correspondent in any part of the United States or Canada, and drop it into a box on a street corner. We have no further control over or agency in it; but we are perfectly assured that it will in no long time, within a week, even if its destination is San Francisco, be delivered to the correspondent. And, if we wish to write a long letter, we have only to add another cent and purchase a postage-stamp, for which a letter weighing one ounce may in like manner be sent and delivered. Now the ability to do this is shared by rich and poor alike, for there is hardly any depth of poverty which precludes any one from doing what I have described. But there is no step in the transaction, from the purchase of the stamp or card to the delivery to the correspondent, or in the antecedent conditions which make it possible, which is not an invention. I can not attempt to enumerate the inventions directly or indirectly involved, and I refer to the matter only as an illustration of the results which have been reached by invention in placing things highly important or desirable to men within the reach of all. It is not many years since the rates of postage in this country were so high, varying from six cents to twenty-five on each sheet, that a correspondence with distant friends involved an expense which could be but sparingly indulged by laboring-men, and was felt to be a burden by many in comfortable circumstances. The cost of sending a letter four hundred miles was equal to the price of half a day's work at the common monthly rate of wages of agricultural laborers. Now a letter may be sent ten times as far, at one twelfth the cost, and in less than one tenth the time.

A few years after Watt invented the steam-engine, and while he was laboring to improve it and adapt it to the various wants of the world, a wonderful military genius arose in Europe, who filled the world with his fame and made himself as large a place in history, perhaps, as any man ever did. He played havoc with the nations of Europe, changed the boundaries of countries and their forms of government, and apparently raised France to the highest pitch of power. But he lived to destroy. Measuring Bonaparte and Watt by their works and their works by the consequences which followed them, and which must stand as the greater fact in the history of the world? Which controlled most potently, for his own time and for the future, the destiny of nations, and which most deserves the admiration and homage, not to say gratitude, of mankind?

I hear people not infrequently express the belief that man will soon exhaust the field of invention. The inventions of the last century have been so numerous and wonderful that to many minds it seems most likely that man will soon reach the limit of his power, or that he will exhaust the resources of Nature. But there is little reason to fear that either condition can be reached for ages, if ever. It is as little likely that man will ever reach the limit of invention as it is that he will be able to fix the bounds of the universe. Man makes inventions by combining the materials and forces of Nature, so as to reach new results. Let any one consider how numerous are the materials which Nature presents to the observation and use of man, how varied in kind and degree are the forces which are in constant operation, and how multifarious and intricate are the laws which govern their actions and relations, and then calculate, if he can, the number of possible combinations which can be made. I have seen the statement, which is no doubt true, that the fifteen blocks in the gem-puzzle can be arranged in more than a million different ways. If this simple toy possesses such capabilities, what possibility is there that man can ever exhaust the field of Nature? Wonderful as man's inventions are in number and character, they are at an infinite distance behind the works of Nature. What a multitude of created things there are in Nature, looking simply at species and varieties, and not at the individuals! How many kinds of plants and animals are to be found! What multitudes of reptiles and insects! No machine which man has invented calls into play such wonderful forces or is governed by such wonderful laws as the humblest plant on which he treads! Man is far enough yet from inventing a structure which shall build itself up from the earth, air, and water, and scatter germs for its indefinite reduplication! He has succeeded in copying some of the products of Nature, and he will achieve still greater results, but in doing it he has but opened a new field of invention, one which only a few years before seemed utterly beyond his reach. He has enlarged the field of invention, not exhausted it. A striking instance of what man has done in this new direction is exhibited in the substance called alizarine. It is the substance which gives to madder its coloring quality. Not many years ago, madder was extensively cultivated in many countries to supply the demand for the arts. Now the article is made artificially from coal-tar, and the fields where madder was cultivated have to be devoted to other purposes. Invention has taught man how to make indigo, and the artificial article is likely to supplant the natural product. Diamonds have been produced artificially. I have full faith that sugar will in time in like manner be produced artificially. Starch and oil may not unlikely be provided in the same way. Man now cultivates the silk-worm which devours mulberry-leaves and converts a large portion into a glutinous fluid which, when spun out into a fine thread, hardens and forms our silk. Man may yet learn how to extract silk directly from the leaves, and perhaps even produce the substance which the worm elaborates, and spin it into silk !

Since the telephone has shown that man, through the agency of electricity, can talk with his fellow-man hundreds of miles away, there are men daring enough to think that through the same agency man may yet see things at an equally great distance, so that you may not only talk from Boston to your friend in New York, but may actually see him as if face to face, and they claim that their attempts have been attended with some degree of success. Would you dare to say it is more unlikely that such a result may be achieved than that man should be able to transmit intelligence instantly three thousand miles through the depths of the ocean? Through long ages man remained unconscious of the presence and action of the forces of magnetism and electricity, but we now know that they are constantly present everywhere, and incessantly active. What other forces may still be hidden from the observation of man it is impossible to know.

The present scientific belief is that the atmosphere is an aggregation of infinitely small molecules, which really fill but a small part of the space the air seems to occupy ; that through the unoccupied space these molecules are rushing at a high speed, hitting each other and the solid bodies around them and rebounding, and that what we call the pressure of the atmosphere, fifteen pounds to the inch, is really the bombardment of these molecules upon whatever arrests their course. The reason that all solid things are not swept away by this incessant pounding is, that the blows are struck in every direction, and so neutralize each other. But here is an ever-present and ever-active force, and, if man should ever discover a way to make all the particles of a body of air move in one direction, he would have at every place on the surface of the earth an unlimited amount of power placed at his command.

But even if man should accomplish all this, there would still be an infinite distance between anything which he could devise or construct and the organic structures which grow up around him ; between the forces which he could wield and those exhibited in the operations of Nature ; and each step which he might take, while it would enlarge his knowledge, would at the same time bring him into the presence of new mysteries, and open up to him new problems for solution. Each new invention gives birth to a host of other new ones.

The steam-engine has been the study of inventors for a hundred years, and each year has witnessed improvements upon it, and such improvements are going on more rapidly than ever before.

About forty years have elapsed since Howe gave the sewing-machine to the world, and thousands of inventions for its improvement or adaptation to new uses have been made, and they are going on still. The same is true of reaping-machines, spinning-machines, looms, the manufacture of iron and steel, printing and telegraphy, and of almost everything used by man.

There is no sign that the work of the inventor is near its end, and those who believe, as I do, that he has been the chief agent in the progress of the world, have no reason to doubt that the world will be still more deeply indebted to him as the centuries go by.

There are now in force in this country more than two hundred and fifty thousand patents for inventions, the fruits to a very large extent of the mental labor of those who are called the laboring-men of the country. Aside from the direct value of these inventions in promoting the comfort and increasing the wealth of the country, there is another factor to be considered, having the most vital relation to the industries of the country and its powers of production. This large number of inventions implies a high degree of intelligence and mental activity in the great body of the people. It indicates trained habits of observation and trained powers of applying the knowledge which has been acquired. It shows an ability to turn to account the forces of Nature and train them to the service of man, such as has been possessed by the laborers of no other country. It suggests as pertinent and most important, the inquiry whether any other country is so well equipped for competition in production as our own; whether in any other country the laboring-man is as efficient and his labor therefore as cheap as in our own; whether he does not exhibit the seeming paradox of receiving more for his labor than in any other country, and at the same time doing more for what he receives—giving more for what he receives, and receiving more for what he gives.

COLORADO AS A WINTER SANITARIUM.

By SAMUEL A. FISK, M. D.

WITHIN the past year the civilized world has been shocked and saddened by the knowledge of the great devastation wrought by the cholera in Spain; and every precaution, in the way of sanitary measures and quarantine regulations, that modern science could suggest, was taken to prevent its spreading into other countries. The public scanned the columns of the daily press, eager for information with regard to the advance of this fearful disease, and read with bated breath as they learned that it numbered its victims by the tens of thousands.

If it was a matter of such deep and universal concern that in Spain 101,000 souls gave up their lives to this fell destroyer, should it not also be a matter of some interest to our own people that, within the borders of these United States, over 91,500 persons die each year of pulmonary consumption?*—that twelve out of every hundred deaths are caused by a disease which, though slow in its progress, is as sure in its results as cholera itself?

* Census, 1880.

Should it ever transpire that some means of prevention should be found, by means of which people would be rendered proof against the disease, or at least could be cured when once it had set its seal upon them, would it not be one of the greatest boons vouchsafed to man since the introduction of vaccination?

Inventive persons have from time to time thought that they had secured a sure cure, if not an unfailing prophylactic; and, at the present time, since the discoveries of Koch, all sorts of parasiticides are being used to kill the germ of the disease. The unfortunate *bacillus* is now being hunted down with pneumatic chambers, deep inhalations, and local applications introduced by means of the hypodermic syringe, with results that are, to say the least, uncertain.

But, after all the years of research devoted to the subject, and out of all the methods of prevention and cure that have been suggested, the one that has given the best results, and is now being universally adopted, is change of climate.

Says Professor Frankland, in an article on the "Yellowstone Park as a Winter Resort," which was published in a recent number of "The Popular Science Monthly," * "The great importance of a winter sanitarium for patients suffering from or threatened with consumption and other allied diseases has long been recognized and acted upon in Europe."

Such patients have been hurried off to Mentone and the Riviera, or sent across the Mediterranean into Northern Africa, or they have been told to take a trip up the Nile, and, more recently, they have been congregated at Davos in the Engadine.

If it be true that, on the other side of the waters, they have recognized the importance of a change of climate for the cure of consumption, it is also true that the public and medical profession alike, in our own country, are also awakening to a due sense of its efficacy.

We have our Florida, South Carolina, and Cumberland Mountains, the Adirondacks, Southern California, Minnesota, and Colorado, and New Mexico, where patients are sent indiscriminately, each one of which places has its coterie of especial admirers, and over the respective merits of which a great deal of verbal warfare has been waged.

It is not the intention of the writer to enter upon any arguments with so-called climatologists as to what are the specific elements of a climate adapted to consumptives, nor to give a detailed comparison of the several resorts. Each place can undoubtedly give its instances of remarkable cures, as can also Cape Cod and certain portions of New Jersey; and some rare and isolated cases could also be cited where complete recovery has resulted even in the large cities; but the point is, to determine just where and under what conditions we may invariably look for the best results.

To be able to speak *ex cathedra* on such a matter would require an

* July, 1885.

experience such as falls to the lot of but few, and a long and careful investigation of statistics which have not as yet been compiled.

It is therefore the intention of the present article to give testimony only in regard to the climate of Colorado; to point out to those seeking such information what they may reasonably expect to find here; and to proclaim to that large invalid class in the East and South, to which we ourselves at one time belonged, the restoration to health which we, with thousands upon thousands of others, have found in this glorious climate.

Comparison of Climatic Conditions with those at Davos.—Professor Frankland, in the article quoted, sums up the climatic conditions prevailing at Davos, which he establishes as a criterion, as follows, viz.: "1. Great elevation above sea-level (5,400 feet). 2. A continuous and, during winter, permanent covering of snow. 3. A minimum of watery vapor in the air. 4. A clear sun. 5. A clean atmosphere, free from zymotic germs, dust, and fog. 6. A sheltered position, favorable for receiving both the direct and reflected solar rays."

A comparison will show that, in all but one of these conditions, Colorado can make a favorable showing with Davos, and that, taking everything into consideration, she can come nearer to fulfilling the requirements than any other portion of the United States.

As regards this single condition, that of having a perpetual covering of snow, whatever may be its effects upon the Davos climate, we of Colorado have been wont to consider it a great point in our favor that, throughout the winter, we are almost entirely free from snow, and that our sandy and porous soil drinks it up rapidly when it comes. We have regarded this as an advantage, because our sun-temperatures are warm enough without the additional heat of the "reflected rays" that come from snow; because its presence would interfere so materially with the out-of-door life that our invalids lead; and because experience has shown that, where there is the continuous covering of snow as occurs in the Northwest, there comes the thaw, which is usually synchronous with the thaw at the coast, and which brings in its train great atmospheric moisture and chill, and that, too, at a time when patients are seeking to avoid similar conditions at their homes.

In order that we may prove our assertion with regard to our having so little snow, we introduce a table showing the exact amount in inches of rain and melted snow that fell at Denver during the winter of 1884-'85:

TABLE OF PRECIPITATION.

1884-1885.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April.
Amount in inches of rain-fall and snow-fall......	0·13	0·21	0·19	0·76	0·41	0·75	0·97	4·94

To return now to a consideration of the conditions prevailing at Davos, which may, in the main, be taken as those which are most highly esteemed by the advocates of elevated and cool resorts, we find in Colorado that, so far as elevation is concerned, the range in the towns is from that of Denver, at 5,280 feet, to that of Leadville, which is somewhat over 10,000 feet above sea-level. Intermediate are Colorado Springs, 6,000 feet; Manitou Springs, between 6,000 and 7,000 feet; Cañon City, about the same; Salida, 7,000 feet; Poncha Springs, Idaho Springs, Boulder, and Longmont, about 7,500 feet; Gunnison, Georgetown, and Alamosa, in the neighborhood of 8,000 feet, and so on. So that all the arguments derived from elevation above sea-level are applicable to Colorado as well as to Davos.

If at Davos it is found that there is diminished atmospheric pressure; that, as a consequence, there is a slower abstraction of heat from the body, so that low temperatures do not feel so cold as they would in a lower and denser region; that there is greater heating power in the direct rays of the sun, and that there is a freedom from germ-life (a supposition based on the experiments of Pasteur and Tyndall), all due to simple elevation, the same has been found to be true in Colorado.

As regards the humidity of the air, on which condition writers on climate lay so much stress, and among them the author to whom we have already referred, the data are full and satisfactory.

Colorado is situated in the zone of greatest atmospheric dryness, both relative and absolute, of any inhabited portion of the United States.

A compilation of the statistics of the Signal-Service Bureau, United States Army, shows that the mean relative humidity of Denver for four years was only 45·8. That is, taking the saturation-point, or the point at which the atmosphere is holding all the moisture that it can, as 100, then the air at Denver is only 45·8 per cent of saturation, and it is capable of holding 54·2 per cent more moisture than it does. The same table shows that the air of New York is 70·2 per cent of saturation; that of Jacksonville, Florida, 69 per cent, and that of Los Angeles 65·8 per cent.

It must be understood, in this connection, that the saturation-point is not at all a fixed one, nor is it a constant quantity at any given place, as it varies both with the barometric pressure and with the temperature; so that, as a consequence of this, many writers prefer to speak of the absolute rather than of the relative humidity, in making comparisons of the atmospheric dryness of places.

Several years ago we had occasion to point out, in this connection, that, while a mean for four years showed that the Denver air contained only 1·81 grain of vapor (by weight) to the cubic foot, the air of Jacksonville contains 5·38 grains, and that of Los Angeles 3·77 grains, to the foot; or, as we then remarked, an "amount which, as between Denver and Jacksonville, is as 1 to 3, and, as between Denver and Los Angeles, is as 1 to 2." *

* "Climate in the Cure of Consumption" ("Science," September 28 and October 5, 1883).

Since the above was written, the subject has been very graphically presented by means of colored maps, published in the "Report of the Chief Signal-Officer" for 1884, which maps were compiled at the suggestion and earnest solicitation of the Colorado State Medical Society.*

They show plainly that, in the spring and autumn of 1882, the portion of the United States which contained the fewest grains of vapor to the cubic foot of air (viz., 1·5 grain) was the portion of the Rocky Mountain range reaching from near the northern boundary of Wyoming to about the center of New Mexico and Arizona; and that, while during the winter months the Northwest, owing to the extreme cold, contained only from 0·5 to 1·0 grain of vapor, that section which we are considering contained the same amount throughout its northern half, while its southern half ranged from 1 to 1·5 grain. During the same winter months the vapor along the California coast is marked as having been 2·5 grains to the foot, and in Florida it was 4 grains in the north and 7 grains at Key West.

We wish to emphasize this matter of extreme atmospheric dryness, as it not only plays a most important part in a consideration of the climatic cure of consumption, but it is also a prime factor in making, what to an Eastern mind may appear as low temperatures, not only bearable but even comfortable.

Says Professor Frankland, "The absence of suspended watery particles in the air has, no doubt, very considerable influence in preventing the chilling of the skin"; and this, together with diminished atmospheric pressure—which, the same writer says, makes the air, if still, feel warmer at an elevated station than in lower and denser regions of the atmosphere, "in consequence of the slower abstraction of heat from the body"—these conditions, we say, are the reasons why low temperatures with us do not feel so cold—and, so far as being out of doors is concerned, really are not so cold—as the corresponding temperatures at sea-level.

The next favorable atmospheric condition mentioned as existing at Davos is the fact that there is a "clear sun," by which, we presume, is meant an absence of clouds and a large amount of sunshine.

In this connection we have previously called attention to the fact that there are in this climate, on the average, three hundred and twenty sunny days per annum, when the invalid can be out of doors. In other words, our cloudy days, as interpreted by the Signal Service —i. e., days when the heavens are from seven tenths to ten tenths obscured by clouds at 7 A. M., 3 and 11 P. M., Washington time—our cloudy days average only forty-six, while in New York they average one hundred and nine, at Jacksonville eighty-seven, and at St. Paul one hundred and four per annum.

This fact also has been graphically portrayed by another series of

* As a member of the committee from that society, intrusted with the matter, we take pleasure in acknowledging the courteous attention our request received.

maps, furnished by the Signal-Service Bureau to the Colorado State Medical Society, at the time that they gave the series illustrating absolute humidity. This is a series of four maps, representing in color and by seasons the amount of cloudiness existing throughout the United States. They show that Denver was in the region of greatest sunshine for the autumn and winter of the year 1882, while in the spring months of the same year the greatest amount of sunshine was found in lower Arizona, and the country immediately surrounding it.

This element of sunshine, as affecting the ability of an invalid to lead an out-of-door life, can not be too highly estimated. That most eminent authority, Dr. Austin Flint, in speaking of the good to be derived in cases of consumption from a life out of doors, writes, "It is probable that to this source much of the benefit derived from change of climate is to be referred." * Certainly the experience of every practitioner of medicine, who has had much to do with treating the disease, will bear out the assertion of the distinguished writer, and it may safely be said that, *cæteris paribus*, a patient's recovery will depend very largely upon his ability to lead an out-of-door life.

So well recognized a principle is this, that our medical journals nowadays are teeming with instructions to patients, who, for lack of means or other cause, are unable to take a change of climate, as to how they can best lead out-of-door lives at home, going so far, in some instances, as to advise them to wrap up warmly and sit in an open window, where they can get sunshine and fresh air without a draught.

Finally, stress is laid on the fact that Davos is in a sheltered valley. Without going into details, for it is not necessary to enumerate such places, it may be stated that there are towns situated at various elevations among our mountains and foot-hills, so sheltered as to be very free from winds, and adapted to receiving both the direct and reflected rays of the sun.

If it be admitted, then, that the Davos climate is the ideal one for a consumptive—and the writer of the article referred to, together with many European authorities, seems to regard it as such—we think that we have clearly proved that, as regards the elements of great elevation above sea-level, a minimum of watery vapor in the air, a clear sun, a clean atmosphere free from zymotic germs and fog, and a sheltered position, Colorado fills the bill as completely as does Davos itself.

Consideration of the Climatic Conditions of an Invalid's Day.—It may not be out of place now to refer to the charges that some writers have preferred against this climate. One throws it up against us that we have high winds, which cause our visitors to complain.† Another says, "The enormous monthly and also diurnal range of temperature must severely try any man." ‡ While a third,

* Pepper's "System of Medicine," vol. iii, p. 432.

† "Boston Medical and Surgical Journal," June 12, 1884.

‡ "New York Herald" editorial, December 29, 1883.

who has published one of the fairest and most intelligent articles ever written on our climate, criticises the statistics so far published as inadequate, inasmuch as two of the three observations, on which they are based, occur at 5 A. M. and 9 P. M.—hours that in no way concern the invalid.*

With a view to answering these objections and those of other writers, we append the following tables, compiled from the official data on record at the Signal-station in Denver. We have taken the months that may fairly be considered as the invalid's winter, and the hours that constitute the invalid's day, and we have selected the winter closest at hand (at the time of writing), so that the reader may from his recollection compare the data we present with the conditions existing at the place where he was at that time.

We furthermore hope that these figures may be of service to those who may be meditating coming to Colorado, as showing them what climatic conditions they may reasonably expect to find:

1881-'85.		Mean temperature.	Relative humidity.	Wind prevailing.	Velocity per hour.	Days without sunshine.	Foggy days.
9·08 A. M., local time...	September..	67·4	59·6	S.	5·3	2	0
	October....	56·2	48·2	S.	1·5	7	0
	November..	41·6	45·4	S.	5·7	3	0
	December...	25·6	61·6	N. & S.	6·3	11	0
	January....	27·0	56·2	S.	7·	5	0
	February...	31·9	65·0	N.	8·5	9	0
	March......	41·3	51·5	S.	6·	4	0
	April......	47·7	55·5	N.	5·3	12	0
			52·8		5·7	6·6	
1·08 P. M., local time...	September..	75·4	25·5	E.	7·5	0	0
	October....	61·1	32·2	N.	6·1	2	0
	November..	53·3	31·6	S.	6·7	4	0
	December...	32·5	54 1	N.	6·7	9	0
	January....	35·8	48·6	N. & W.	8·1	5	0
	February...	38 0	57·4	N. E.	10·4	9	0
	March......	48·2	39·5	N.	9·2	5	0
	April......	53·9	43·1	N.	9·3	5	0
			41·5		8·0	4·8	
5·08 P. M., local time...	September..	74·6	28·0	N. E.	8·6	3	0
	October....	64·1	37·7	N. E.	7·4	5	0
	November..	49·9	37·3	N.	6·4	6	0
	December...	26·8	63·4	N.	6·8	9	0
	January....	33·3	53·1	W.	8·7	3	0
	February...	37·8	55·5	W.	11·2	5	0
	March......	47·7	40·9	N. E.	10·7	7	0
	April......	54·3	47·8	W.	9·1	6	0
			45·5		8·6	5·5	

FOGS.—A study of these tables shows that such a thing as a fog is of very rare occurrence, there not being a single one recorded at any of the three observations.

* Dr. Edward T. Ely, "New York Medical Journal," July, 1884.

Humidity.—We next observe that, of the three observations, the air carries the most moisture at the 9 A. M. one, an amount which is, on the average, only slightly in excess of one half of saturation; that the midday air is quite dry, giving a mean for the eight months of 41·5 of saturation; and that at 5 P. M. the average of humidity is 45·5 per cent of saturation—all of which simply strengthens what we have previously said in regard to the dryness of the Colorado climate.

Temperature.—As regards the temperature we learn that, as we should expect, the coldest registrations occur in the months of December, January, and February; and that even in these months an invalid can be out of doors, so far as this factor is concerned, from 9 A. M. to 5 P. M.

In considering this question several things must be borne in mind. In the first place, these registrations are those of thermometers placed in a "shelter-box," and consequently in the shade, with a northern exposure, and ten feet above the roof of a six-story building, and so they are not influenced by the direct solar rays, which are very powerful. It must further be borne in mind that these registrations do not "feel" so cold as similar ones would in a dense and damp air, like that of either New York or Boston, owing to the fact that we have mentioned, viz., that a thin, dry air does not rapidly rob the body of its heat, and so the skin does not become chilled so rapidly as at sea-level with the same temperature.

As a matter of fact, the writer remembers that he went around at midday the greater part of the winter without an overcoat. He recalls sitting with open windows in the very heart of January, and was accustomed to seeing people sitting out of doors basking in the sun.

And right here he is willing to acknowledge that there is a grain of truth in the criticisms broached with reference to our extremes of temperature, both diurnal and monthly. They do occur, but then only rarely (that is, such extremes as have been quoted against us), and, when they do come, they are due to high temperatures in the daytime and very low ones at night—conditions which can occur only in thin, dry airs like our own.

The night temperatures are uniformly cold; but they do not affect the invalid, because he should at that time be housed, where he can regulate the temperature to suit himself, and our tables show conclusively that the hours of sunshine are warm and comfortable.

We regret exceedingly that we are not able to give the "sun-temperatures," as they would convey a more correct impression of the warmth of our midday, as every person knows who has tried the difference between the shady and sunny side of the street in our city. But we know of no data on that point, and our Signal-station is not as yet supplied with a sun-thermometer.

Winds.—As regards the winds, these tables prove that in Denver at 9 A. M. the prevailing direction is from the south, and that at 5

P. M. it is either from the north or west. They do not, however, show the well-recognized daily change from the south at night to the north during the day. Furthermore, the observations have reference only to Denver, and can not be taken as a guide for other places, where the peculiar topography must exert a controlling influence.

Moreover, the tables teach most conclusively that the mean hourly motion, at any one of the three observations, is mild, and probably rather less than would prevail in New York city at the same hour of the day. Certain it is that in 1880 the corresponding mean velocities for the twenty-four hours were as follows, viz.:

1880.	Spring.	Summer.	Autumn.	Winter.
Denver	156 *	143	115	127
New York	247	177	192	222

While our tables show that the average hourly movement of the wind is moderate, it is true, as some object, that we do have occasional squalls, when the dust is picked up by the wind and when it is disagreeable to be out of doors. We speak of the dust, for it must be remembered that snow does not lie on our ground, even in midwinter. But such squalls are no more frequent than one will meet with in the autumn months in Boston. In violence they bear no comparison, as we can testify from personal experience, to many a tornado that has occurred of late years in the valley of the Connecticut River, and should by no means be confounded with the blizzards of the Northwest nor the cyclones of Kansas.

Sunshine.—We next learn, from a consideration of the tables, that while there occurred days in the winter under observation when the sun was not shining at 9 A. M. or at 1 P. M. or at 5 P. M., as the case might be, there were only eleven days in the whole eight months when the heavens were completely and wholly obscured at all three observations. In other words, there were only eleven days in the winter of 1884–'85 when the sun did not shine upon Denver between the hours of 9 A. M. and 5 P. M., and they occurred as follows, viz.:

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	Total.
Completely cloudy days, from 9 A. M. to 5 P. M.	0	1	1	1	1	1	3	3	11

We may fairly conclude from these figures that there were only eleven days, out of the two hundred and forty-two, when the invalid was detained in doors all day long for want of sunshine.

* The figures in this table should read so many miles *per diem*. In the former tables the velocities are given in miles *per horam*.

While in New York recently, we tried to obtain data of observations at 9 A. M., 1 and 5 P. M., local time, as a means of comparison, but they were not to be had at the Signal-station.

Surely this is a surprising showing, and one which, in itself, sufficiently indicates the character of our climate.

Résumé.—To sum up, then, the information we have gathered with reference to the nature of the Colorado climate, between the hours of 9 A. M. and 5 P. M., the invalid's day, and during the eight months from September to April inclusive, the invalid's winter: we have learned that the days are very few, probably not more than two in a month, when an invalid can not be out of doors, gaining health and strength; that the air is warm enough to admit of his being out the greater part of the time from 9 A. M. to 5 P. M., and by this we mean with comfort (certainly, even the most sensitive invalid can get several hours out of doors at midday); that, while there are occasional high winds, they are not more frequent than occur elsewhere, and the average daily motion is mild—not more than is enjoyable and conducive to purity; that the air is an exceedingly dry and bracing one, and that fogs are of very rare occurrence.

Are there not in these conditions the most desirable elements of climate for the consumptive? Here are to be found the greatest amount of sunshine to be had anywhere in the United States; a dry air, a rarefied and pure air; absence of fog; a dry soil free from snow and moisture; a temperature that admits of out-of-door life with comfort; and a daily movement of the air that is mild and gentle—all of which conditions combine to tempt the invalid to a life in the open air.

Says Professor Frankland of Davos, "In the brilliant sunshine one feels comfortably warm sitting in front of the hotel in a light morning coat." What would he say of a climate where the sun shines so brightly and the air is so mild that picnics are admissible, and out-of-door sports, such as riding, driving, tennis, quoits, etc., can be indulged in the greater part of the winter?

Before concluding the article, we wish to say a few words in regard to what seems to us to be the weak point of Professor Frankland's advocacy of the Yellowstone Park as a winter sanitarium; an objection which, we think, would be sufficient to condemn any place as a resort for consumptives, no matter how advantageous its climate. We have reference to its distance from the settled portions of our country, and the lack of accommodations in the park itself. These features, which Professor Frankland recognizes and mentions, must, for the present at least, put the Yellowstone Park entirely out of consideration as a winter resort for the consumptive; for he will not be willing to subject himself to a journey of five or six days by rail, a stage-ride of thirty hours, and the utter isolation of such a place, to say nothing of its lack of accommodations, simply that he may winter in an elevated region, possessing "a continuous and, during winter, permanent covering of snow"—a covering of snow which, by-the-by, is deep enough, so I am credibly informed, to drive the big game from the park during the winter months.

Here in Colorado, however, the invalid can find comfortable and adequate accommodations at reasonable rates. He can enjoy the comforts of settled communities at the same time that he is putting himself under superb climatic conditions. He will have access to a market which can amply supply his demands, even should he desire such delicacies as a live lobster or oysters in the shell. He will be in direct telegraphic and postal communication with his home, and, should occasion demand, can walk the streets of Boston within three days of leaving Denver.

These are considerations of no little weight to the invalid, for he is a human being, sensitive like other human beings—in fact, rather more dependent on the comforts of life than other men—and he protests, and rightly too, that it is cruel to impose conditions on him which would depress and render sick even a strong and able-bodied man.

The idea which has been so prevalent, and which even now is not entirely eradicated, that to regain health it is necessary to "rough it," and the greater the privations one endures, the more he roughs it, the sooner he will get well, is an erroneous and most cruel one.

It is not necessary to pander to the consumptive so as to make him a hypochondriac; and yet, on the other hand, we protest against the rough usage so often entailed upon him, which would seem to justify the idea that the only way of curing the disease is by fairly knocking it out of a man.

We consider the proper regulation of an invalid's life as regards exercise, diet, hygienic conditions, accommodations for living, etc., as of great importance—equal, it may be, to considerations of climate.

We have already * given to the public our opinion of what they can expect to find, on such scores, in Colorado, and need not now weary the reader with a repetition.

We at that time took occasion to mention the kind of cases that, in our opinion, should *not* come to Colorado, and we will now briefly repeat the advice. It is an excellent place for persons in whom a recovery can reasonably be expected, but it is not a place where consumptives should be sent as a last resort.

In conclusion, we can only say that, if the figures and arguments we have adduced are not convincing, or if the reader is skeptical about the ranges of temperature and unbelieving in regard to the heating effects of the direct solar rays, or the further fact that low temperatures do not feel so cold in our light and dry air as at sea-level, or if he can not reconcile the facts presented with any theory he may hold, we can only say to such a one, "Come and see."

The theories in regard to the beneficial elements of elevated regions may be entirely erroneous. Men's theories are constantly changing, and it may or may not be true that elevation, dryness, and sunshine

* "Colorado for Invalids," "Popular Science Monthly," July, 1884.

are the sole desiderata in selecting a suitable climate ; or, on the other hand, that equability of temperature should alone be considered.

Writers may still object that we have high winds and sand-storms, which annoy the visitor ; or that "the enormous monthly and also diurnal range of temperature must severely try any man" ; or raise one objection after another on merely theoretical grounds : and yet the fact remains—a fact that rises superior to all argument and cavil, and which is in itself the most conclusive argument that can be advanced—that a large percentage of our population is made up of the so-called invalid class, who have obtained a restoration of health here ; that thousands upon thousands of lives have been saved to the world, not to drag out an invalid's existence, but rather to take a manly part in the struggles of life, simply by coming to Colorado ; and that to-day there are living within its borders persons, to be numbered by the tens of thousands, who would undoubtedly be glad to attest their gratitude to the climate by saying of it, as the writer thinks he can truthfully say, "It saved my life."

DURABILITY OF RESINOUS WOODS.

By HEINRICH MAYR, Ph. D..

THERE can be no doubt that the resin in the wood derived from the different varieties of conifers, or pine-trees, is one of the most important factors which determine its quality, especially its durability and resistance against the influence of weather and the different forms of rot, all of which are now proved to be due to specific fungi. Just at present, timber from American conifers is highly valued in Europe, because of its richness in resin, although the amount of resin in wood is not the sole measure of its quality.

Until now an exact valuation of the importance of pitch in wood was impossible, because the accurate knowledge of the origin and the distribution of the resin, as well as of the arrangement of the organs producing it, was wanting.

At the experimental botanical station at Munich, I have made numerous experiments during a space of many years, and, as the results seem to contain many new points, I thought them worth presenting to the readers of the "Monthly." In face of the confusion prevailing in the nomenclature, it is necessary to state that the botanical names used are those of Carrière in his "Traité des Conifères," who separates *Abies* and *Picea* as distinct genera. The distribution of the resiniferous ducts is so characteristic within each of these genera as to serve as typical marks for them.

The species of *Abies* commonly called firs are characterized by the absence of resiniferous ducts within their woods ; it is only in rare cases, as in *Abies firma*, or Japan fir, that we meet with them. Sometimes we find a cluster of parallel cells, often quite far apart from each other, filled with resin; these colonies of parallel cells are not to be considered as ducts, but as malformations due to the influence of different causes like cold and pressure; they are found also in other species of conifers exposed to the same causes, and occasionally attain the size of a man's hand.

The resin is produced only by the parallel cells of the medullary rays in the species *Abies*. Already in the first year's growth the cells are found to contain small drops of resin. The size of these drops increases with the age of the cells, the amount of amylum or starch in them decreasing in proportion.

Resin is composed of substances volatile at 100° C., and others which can not be distilled without decomposition; the latter form the solid residue, when resin or pitch is distilled with water. When the outer or sap wood (*alburnum*) becomes dry or heart wood (*duramen*), in which form it is that which is known commercially as wood, the cells are found to contain nothing but air with the resin coating the inside of the cell-walls; fresh pitch, as it oozes from the bark of the European *Abies pectinata*, contains 63 per cent of solid residue, and this is also the percentage of solid substances in the pitch of the sap-wood of the genus *Abies*, but pitch from the heart, or from the dry, inner wood of the tree contains 70 per cent of solid substances.

During the life of a fir-tree the cells contain 50 per cent water, which, when the wood dries, disappears, and the pitch, which at first could not enter into the cell-walls, now permeates them, taking the place of the water.

The wood of *Abies pectinata*, which in Europe covers thousands of acres in dense, well-cultivated masses, contains the least resin of any fir cultivated, namely, only $\frac{72}{100}$ per cent of the perfectly dry sap-wood, while the innermost layers of heart-wood contain $1\frac{1}{3}$ per cent of pitch; it is therefore of inferior quality as far as richness in resin is concerned; only the very great heights and diameters which trees of this species rapidly attain make them valuable for cultivation.

The genus *Picea* (spruce) has the sap-wood of the same color as the heart-wood; it contains numerous ducts filled with resinous substances. These ducts run in all directions, the horizontal ones being branched off from those running perpendicularly, and communicating with others lying closer to the bark, running vertically. The inside of the ducts is made up of two kinds of cells, the one having thick walls and the same functions as the parenchymatic cells of medullary rays, the others having thin walls. The latter were formerly considered as mere cells of secretion producing resin; but there are many reasons which force me to consider them as merismatic cells, remaining without function sometimes for several years, until the sap-wood containing them becomes dry or heart wood, when they begin their activity. They now increase in size, expanding like vesicles, and totally obstructing the duct, so as to prevent the resin from entering the heart-wood by way of the horizontal duct or sinking from a higher to a lower part of the tree. In the amount of resin contained in the wood, the genus *Picea* ranks second among conifers; the species *Picea excelsa*, common in Europe, contains 2·16 per cent in the sap-wood and 1·6 per cent in the heart-wood. The amount of pitch increases with the age of the tree.

I have found as a result of my investigation that there exists a very important law which will enable a microscopist to tell at a glance the difference between heart-wood and sap-wood: only the heart-wood is fit for building purposes and will stand the influence of weather; the sap-wood will decay rapidly, but is nevertheless used by unscrupulous builders. An examination of the resiniferous ducts will show the difference at a glance. During the process of transition of the sap-wood into heart-wood, *all these resiniferous ducts become closed* by the expansion of the cells surrounding them, a process which can be discerned unmistakably even in the smallest piece of any wood from a conifer; a similar process takes place in the growth of the bark.

Professor Hartig, of Munich, a famous botanist, proved by careful experiments the following law: *The quality of the wood of all trees increases so long as the yearly growth shows a progressive course year after year.* It has been thought until now that the quality of the wood of conifers is the better the closer the annual rings lie; this is but partly true. The older the tree the closer the annual rings, but the quality of the wood increases only as long as those rings represent an actual progress of growth; when once the annual amount of wood formed begins to diminish year by year, its quality becomes impaired, notwithstanding the rings become closer and narrower.

The amount of resin in the wood of a tree follows the same law: if we take, therefore, a splinter or a plug from any tree by means of a hollow auger, we can, by a simple calculation, determine whether the tree is still progressing, or already on the decline in growth, quantity of resin, and value.

In the genus *Pinus* the resiniferous canals are of different construction, but agree in general arrangement with those of the genus *Picea*; their size is larger and they are inclosed by only thin-walled, merismatic cells, which in the course of the transformation of the sap-wood into heart-wood enlarge and close the canals.

The heart-wood of the trees of the genus *Pinus* has a light-brown color, sometimes a little reddish, the coloring being due to a product of the oxidation of tannin, which is found in the cells and their walls.

Among the species of this genus several deserve a more elaborate mention:

The Scotch pine (*Pinus silvestris*), when growing on sandy soil, forms only a very small amount of sap-wood, whereas on gravelly and shallow ground it produces more but of less valuable quality. Two needles in one sheath characterize this species. The heart-wood of this pine contains 5·7 per cent of resin, the sap-wood proportionately less.

The sap-wood of this tree is quickly destroyed when the tree is cut; it assumes a dark-blue color and rots, through the agency of the mycelium of a fungus called *Ceratostoma piliferum*.

This tree is at present the most valuable and most cultivated timber-tree of Northern Germany.

The white pine, or common American pine (*Pinus strobus*), is now also extensively cultivated in Germany, where some forests can be found of trees about a hundred years old. Its wood has the lowest specific gravity of all coniferous wood. In spring, on account of the thinness of its bark, the tree is quickly warmed through, and the wood-cells, formed in the beginning of the spring, are thin-walled; at the close of the period of vegetation in summer, the annual rings are finished by a few thick-walled narrow cells, thus giving only little thickness to the hard part of the annual layer. In amount of resin this pine stands at the head of all conifers, containing 6·9 per cent. The percentage increases up to the age of one hundred years, and with it the quality of the wood. It is of little value when young and exposed to moisture. *Pinus cembra*, a native of the Alps and Siberia, forms only small, dense rings every year during the short summers of these regions; the wood hence becomes heavier, and, although less resinous, more valuable.

A very valuable tree of Europe is the larch (*Larix Europæa*), which is native only in the colder regions of Europe and Asia; its wood consists of narrow annual rings, grown during the short summers of those countries. In the percentage of resin it stands between *Pinus* and *Picea*; its wood is more reddish, like that of the genus *Pinus*, and its resiniferous ducts are constructed like those of *Picea*; it contains 3·9 per cent of resin.

Just now, the different German governments are experimenting with the introduction of American trees which, it is expected, will stand the climate and furnish better wood, or, in proportion, a larger quantity, than the German forest-trees now cultivated. One of those of which much is expected is the *Douglas spruce* (*Pseudotsuga Douglasii*). Mr. J. Booth, of Hamburg, has cultivated this tree for a long time, and has already some very fine specimens in his park. I was enabled through his kindness to examine its wood carefully; the specific weight is very much above that of European conifers of the *Pinus* genus, but not as high as that of the larch; its quality increases in proportion to the width of its layers—a fact which, until a short time ago, was considered directly contrary to what is the case with wood from European pines.

Professor Sargeant, of Cambridge, has made the contribution to the United States census which embraces the researches and experiments with American trees. This report, one of the most valuable of its kind from the great amount of statistical information contained in it, has been made with specially painstaking care; the distribution of American trees, the determination of their specific weights, their chemical composition in regard to mineral constituents (ashes), their commercial value, their strength, elasticity, and resistance, form the contents of a large volume. Compared with the figures obtained by Professor Sargeant, the wood of European forest-trees appears to be somewhat inferior in quality to that of American trees. The Bavarian Government, which on its 24,000 square miles of territory has over 7,000 square miles of forests, of which over 3,000 square miles are in solid masses, under a model administration of the Government, yielding about four per cent net profit, is wide awake for improvements, and has sent me to this country to investigate as fully as possible the facts about the growth of American forest-trees, their relation to the climate, and their yield of timber in quantity and quality. With their usual liberality and hospitality, the American authorities and learned men have lent a helping hand, truly worthy the spirit of a great nation not influenced by petty considerations of a possible rivalry.

INFANCY IN THE CITY.

By GRACE PECKHAM, M. D.

ACCORDING to Quetelet, "there die during the first month after birth four times as many children as during the second month, and almost as many as during the two years that follow the first year, although even then the mortality is high. The tables of mortality prove, in fact, that one tenth of children born die before the first month has been completed."

The census has shown that the mortality of infants in cities is twice as great as that in rural districts. In New York, in 1883, 28,972 children were born, and 8,668 died in their first year, thirty-three and one fourth per cent; 2,660 children died in their second year, 1,221 in their third year, 787 in their fourth year, and 525 in their fifth year, a total of 13,865 deaths of infants, almost half of the total number of deaths occurring during that year, which was 31,011.

The question arises, What is it in cities that is so hostile to infant life?

The subject is a complex one, and in its analysis we must consider the varying conditions surrounding the different classes. Distinctions of rank are as definitely marked among infants as among adults. There is none of the democracy which obtains in the country. We have the infant of aristocracy, the infant of the middle classes, the infant of the poor, the infant dependent upon charity. Each of these inherits an environment peculiar to itself; its house, its nursery and sleeping-apartment, its nurses and attendants, who solve the problems of its food and raiment. Take the matter of inheritance, not of money or lands, but of constitution. The extreme classes found in the city and not in the country, the very wealthy and the very poor, are likely to bestow on their offspring a latent tendency to disease. The ultra-fashionable mother, the self-indulgent father, hand down to their children overwrought nervous systems and weak physical powers, which result in early death, or more often a life of protracted feebleness. In the lowest classes the untoward effects upon the children of poverty, intemperance, and moral obliquity are incalculable.

The city infants belonging to the middle classes often suffer because of the struggle of their parents to maintain a foothold in society, and to mount the steps in social life which will bring them distinction. It would be a long discussion to enter into all the questions of heredity which influence the fate of a child. They are vital questions, however, which require the utmost delicacy in handling, but which are of transcending importance to the individual and to the race. Very little of the common sense which prevails in preserving and rearing choice stock exists in relation to the human animal. If by chance the infant is well-born—that is, has the germ of a constitution which will unfold untainted by scrofula or epilepsy, or any other foul disease which will rob it of a healthy mental and physical development as life unrolls before it—such inheritance is unequaled. Dr. Ireland has shown the effects of heredity as seen in tracing through three hundred and fifty years the health history of the house of Spain. The children, though born to a kingdom and a crown, were cursed with an hereditary nervous taint which sometimes passed over a generation only to appear again in various forms and intensities as epilepsy, hypochondria, melancholia, mania, and imbecility, till at length it extinguished the direct royal line.

With a multitude of hereditary tendencies germinating within it, the city infant opens its eyes upon surroundings which are to influence it scarcely less. About city homes lurk unseen perils to babies. There has been much written and said about the plumbing of city houses and the evils which have sprung from it, so that now, when children are afflicted with diphtheria, immediately comes the question, Are there escaping sewer-gases in the house which they occupy? Dr. J. Lewis Smith remarks that diphtheria appeared in New York in 1858 after an absence of more than fifty years, the most severe cases occurring in the upper part of the city along old water-courses, where in consequence of street-grading, water was stagnant and impregnated with decaying animal and vegetable matter. The infants are more liable to succumb than those older, as the poison acts more quickly on their susceptible systems, and, as they are shut up in the house, they are much more exposed to it. Especially is this true in the tenement-house, where the surroundings of the city infant are at their worst.

Lack of pure air, air untainted with human emanations and sewer-gas, is one of the great causes of infant mortality in cities. It deteriorates the health of the naturally robust; it robs the delicate of their chances for life; it sows the seeds of contagious diseases; it hastens the fatal termination of those who are sick.

Many mothers, anxious for their children, with mistaken zeal protect them from the fresh air. They are especially afraid of night air, and shut their babies up in rooms which would make a well person giddy and sick to enter in the morning. In the country, houses are built less substantially and in exposed situations, and the fresh, searching air will find its way in, in spite of unhygienic resistance.

The little ones are too often brought up on the hot-house plan. Mothers, however, are awakening to the fact that babies must have their airings, and among the better classes the nurse takes the baby out every day when the weather will permit. One must admire the beautiful infants in perambulators, the chubby little run-abouts that are to be seen in the city parks and squares. Their handsome faces, finely formed figures, and rosy cheeks, go to show that children in the city, when properly cared for, can become the embodiment of health. In the country the children are usually looked after by their mothers, who have an average amount of intelligence.

Babies who are constantly held and watched and tended do not thrive. They grow fretful, uneasy, and pale, no one knows why. The aristocratic baby is at a disadvantage in this respect, unless money—as it may sometimes—procures an intelligent, faithful nurse, a foster-mother.

To intrust an infant to some baby-tenders is almost as much an act of abandonment as that of the heathen mother, who throws her babe into the jaws of the crocodile of the sacred river. The children who have grown up through a wretched childhood to a crippled and deformed maturity caused by the carelessness of nurses, who have let them fall or otherwise injure themselves, are not a few. Nevertheless it must be said that when the number of nurse-girls who take care of little ones alien to them is considered, the patient devotion and painstaking fidelity they show to fretful children spoiled by indulgent parents are marvelous.

If the rich children are spoiled by over-attention, this can not be said of the children of the poor. The little waif born in the tenement-house, if it has no brothers or sisters, is often locked up by its mother and left an hour or two by itself while she goes out to work, to gossip, or to shop. If she goes out by the day, an obliging neighbor (and the poor are wonderfully helpful to each other) will let the child come into her apartment, where it can sit on the floor or the dirty bed and play, or cry, or sleep, as it will. The neighbor's nerves are not weak as far as children's crying is concerned. The day-nurseries which benevolence has established for the care of these little ones are truly a blessing to poor mothers, who earn their living by washing and scrubbing. The babies are well fed, amused, and generally well cared for, far better than in their own homes; the mothers pay from five to ten cents a day out of their wages. But more often the poor baby has brothers and sisters, and they take care of it almost entirely.

Many city infants perish from bad feeding. More especially is this true of the tenement-children. The youngest member of the family is placed at the common table at an incredibly tender age. Often in the dispensary in response to the question, "With what are you feeding your baby?" comes the reply, "It eats what we all do." With these people, even if they are not extremely poor, milk or anything else purchased especially for the baby, is an item of extra expense, and therefore it is considered easier and cheaper to feed it with the rest of the family. The sins of feeding among the poor people are monstrous. Coffee, tea, brandy-and-water, as well as beer, had been fed to babies from their nursing-bottle! With such a *régime* of feeding for the poor and middle classes, it is no wonder that two and a half times as many infants perish of diarrhœal disorders as of any other disease.

City infants of all classes are at a disadvantage in regard to their food. Unfortunately, city mothers who nurse their own children are fewer than those in the country. The search for a wet-nurse is one of the most disheartening. The supply is in no way proportioned to the demand. A woman of the poorer classes who has any home at all must stay in it and look after it for her husband, even if she were willing to give up her child for the sake of the money. The woman who applies for the position as wet-nurse has either been deserted by her husband or has had none. She must depend upon her own exertions for the support of herself and her child. If she finds a place as wet-nurse she earns from twenty to thirty dollars per month and a good home, for it is only the well-to-do who can afford to hire her. She usually rules the household with a rod of iron. Since, as a general thing, she comes to take care of a puny child who can not live without mother's milk, and recognizes that the family are dependent upon her, she is exacting and aggravating, oftentimes almost beyond endurance. It is only because the thralldom will not last forever that it is tolerated. The wet-nurses obtain their positions through agencies which exist in the large cities and through advertisements. The necessity for a thorough investigation of the health and status of the applicant for such a position by the family physician is imperative, and in recommending one he takes upon himself a grave responsibility. The wet-nurse will generally try to deceive as to the age of her baby, that she may make her milk appear desirable. The best evidence is the mother's own infant, which should be seen if possible. And it must be remembered that even here another imposition may be practiced—a neighbor's baby can be borrowed for the occasion. The flattering testimonials of fidelity and satisfactory conduct in previous positions are often from employers who have departed for Europe or some other quarter of the globe, and are therefore inaccessible. When success has rewarded the search for a wet-nurse, there is no guarantee that her milk will remain satisfactory for any length of time. If she has the true maternal instinct, she mourns for her own child, and it is not long before, deprived of its proper nourishment, it sickens and, more often than not, dies, and the grief of the mother dries up her milk.

The question of artificial feeding becomes, then, one of paramount importance, since the largest proportion of city infants must subsist in this way. In summer it is indeed a difficult task to raise an infant in the city. New York physicians know very well that a large proportion of artificially fed infants who enter the summer months die before the return of cool weather, unless saved by removal to the country.

One of the most benevolent institutions which has been devised is the Floating Hospital of the St. John's Guild of New York, which daily in summer takes its freight of pallid, almost dying, infants, suffering from faulty nutrition, out into the fresh ocean-breezes for the day.

Cow's milk coming from a long distance is unfitted for infant feeding; but, if it can be obtained fresh, it is the best substitute for mother's milk. It must be diluted the first six weeks one half, the next six weeks one third, and after three months a fourth, and at five or six months it can be given pure. The feeding-bottle should be perfectly sweet and clean. It has been found both in private practice and hospital experimentation that milk which has been prepared with the extract of pancreas can be used more successfully than any other. Infants' foods abound in the market, whose inventors claim all sorts of merits for them. For a while one food will prove advantageous, when, having obtained a reputation and come into extensive use, less care is taken in its preparation, and through the suffering of many infants it is proved unworthy of longer confidence. Goat's milk is good for city infants, because it can be obtained fresh, and the animals can be kept by poor people at little expense.

Many an infant suffers from irregularity of feeding and overfeeding. There is in the popular mind but one interpretation of a baby's crying, "It is hungry," and immediately it is given more food to eat, when already its tiny stomach is distended and irritated. Infants' meals should be regulated by the clock.* This prescription, unaided

* An infant under three weeks should be fed every two hours, or twelve times in the twenty-four, receiving one to one and a half ounce of cow's milk each time, if artificially fed. At three months the child should be fed every three hours, or eight times in the

by anything else, has often restored a nursing baby to equanimity and to health.

Of less vital importance to a child perhaps than its food, yet claiming no little attention, is the clothing. The mothers of to-day have learned by experience how to clothe their children better than their mothers clothed them. It hardly seems possible that at one time the fashion of dresses low in the neck and with short sleeves was well-nigh universal for infants. The babies of the aristocratic and middle classes are, as a general thing, warmly and properly clothed. Careless attendants sometimes dress them too tightly, not allowing room for the expansion of the chest and lungs and interfering with the stomach. The senseless extravagance displayed in embroidered dresses for small children is reprehensible, and too fine dressing which prevents young children from obtaining proper exercise and trammels their freedom of play interferes with their health and development. American mothers are often very blameworthy in this respect.

The effects of disease on city infants are much more wide-spread than upon those in the country, not only of disease caused by improper feeding, to which we have already alluded, but more especially of those of a contagious nature. All sanitarians recognize this, and bewail it as one of the greatest evils of the present tenement system that so many children are crowded together in such houses, which become hot-beds of diphtheria, scarlet fever, and measles.

The terrible stories with reference to baby-farming which used to fill the columns of the newspapers are not so often seen in these days. Owing to the ventilation of the subject, the abuse has been very much lessened. But the question may be asked, Who supply the baby-farmers? A few are those who would abandon their offspring, no matter how, to hide their shame, but for the most part they are poor women who are without a home, and must win a support the best way they can for themselves and their infants. They go out as wet-nurses; return to the factories and shops; or engage in general house-work.

The women who find their way, utterly destitute, to the lying-in institutions of a great city, amount to a considerable number in a year. Any of these coming to New York can go to Charity Hospital by obtaining a permit from the Superintendent of the City Poor. They leave the Maternity from ten days to two weeks after confinement. If they wish they can go with their infants to Randall's Island, or they can leave their children there while they go out to seek employment. At almost all other institutions the women are obliged to pay at least twenty-five dollars for board and care during confinement, or stay with their children three months. They can and often do remain with them a year.

twenty-hour, receiving three ounces of milk at each feeding, which at six months is increased to four. The times of feeding should be fixed, but of course the amount taken will vary more or less with the individual.

The charity infant who has opened its eyes in an institution is peculiar to the city. Its chances for life are less than those of any other class. Most of these babies if bottle-fed will die, as has been demonstrated in some of our nurseries. This is not because the infants are especially unhealthy when they come into the world. It is surprising, when one considers what hardships, physical and mental, the mothers have endured, that the children should be as robust and well-formed as they generally are.

In view of the disastrous effects of artificial feeding, the plan now adopted is to have a woman nurse her own baby and one other. In this way the mortality has been greatly reduced. The public infant is probably best cared for when sent into the country and boarded with farmers, and this is now extensively done by some of the institutions.

ARBOR-DAY.

By N. H. EGLESTON.

AMONG the agencies by which we may hope to remedy the evils threatening us on account of the rapid wasting of our forests, Arbor-day promises to be one of the most important. A little thing to begin with, it is capable of such expansion as to become a wide-spread power for good.

For the settler on the naked, wind-swept prairie, to plant trees was one of the first necessities of life. Certainly, without the presence of trees existence there could not be comfortable, and the tendency of one's surroundings was to forbid any but a low type of civilization or of domestic life. Fertile soil is not all that is needful, nor can man live, as he was designed to live, by bread alone.

But manifest as was the need of tree-planting under the circumstances adverted to, it was not easy to effect the work. The very magnitude of it was as discouraging as its necessity was imperative. What could the planting done by a few settlers amount to on those wide seas of verdure, treeless and shoreless? Driven by necessity, as we have said, they did, many of them at least, plant their little groves of cottonwood and other quick-growing but frail trees around their cabins. These gave some shelter to the cabins and their inmates. But what was to shelter the cattle and the crops? The hap-hazard efforts of a few, working here and there without concert, easily spent themselves in attaining results far short of what were needed.

It was the happy fortune of one living as a pioneer in the treeless region of the West, not only to feel with those around him the evils of their peculiar situation, but to devise an instrumentality which would arouse an interest in the needed work and an enthusiasm for it that would convert the necessary labor, to a large extent, into pleasure—at least take from it the character and irksomeness of a drudgery. The plan was, to fix upon a particular day, at the season of the year when the trees are starting into fresh life, and to invite those in the same general region to engage together on that day in the work of tree-planting. The designation of a particular day had the effect to prevent the propitious season of planting from slipping by unobserved, while it had also the advantage and stimulative effect attendant upon co-operative endeavor. The thought of tree-planting was thus at a certain time made as it were to pervade the atmosphere, or rather, perhaps, to become an atmosphere.

Thus Arbor-day, or Tree-planting-day, originated, and the person who put the question, not long since, in the columns of one of our newspapers, "Who invented Arbor-day?" used the right word. We commonly apply the term invention to some machine or mechanical contrivance. But there is no reason for thus restricting its meaning. Arbor-day is as truly an invention as the cotton-gin or the steam-engine, and, like those notable inventions, its importance and beneficial results will be recognized in increasing measure with the lapse of years. Governor Morton builded better than he knew when he gave origin to this day. He was thinking chiefly of his own State, Nebraska, of beautiful name, but swept by the fierce blizzards of the Northwest and the hardly less harmful sirocco-blasts from the torrid South. He was contriving a plan to raise up against these harmful agencies the effective barrier of the leafy trees. His plan commended itself at once to his fellow-citizens, and in the first year of its adoption more than ten million trees were planted. Nor was the happy invention limited in its application by the boundaries of a single State. The people of neighboring States and Territories, with similar needs, one after another, adopted it, until it may be said to have become a fixed institution throughout the prairie region of the country.

But Arbor-day is not for the treeless regions of the West alone. The principle of associated and simultaneous action which it embodies commends it for adoption almost everywhere. States where once the trees were so abundant as to be in the way of agricultural improvement, and to call for the axe and the fire to remove them as speedily as possible, or where their value for lumber had occasioned their rapid and general displacement, are now welcoming Arbor-day to assist them in regaining the condition which they lost by the inconsiderate destruction of their best friends. Thus Michigan, lately a wilderness of forest, and even yet sending to market annually more lumber than any other State, but becoming sensible of the need of trees for other use than to be converted into lumber, has made experiment of Arbor-day, and in his designation of the 11th of April last, by public proclamation, Governor Alger earnestly recommended that on that day "we plant trees by the road-side, by our farm-houses, in our fields, parks, villages, and cities, around our school-houses, and in the cemeteries where sleep our beloved dead. . . . We may not live," he said, "to enjoy the full fruits of this work, but our children and our children's children will receive the benefit of our labor."

Pennsylvania, in keeping with that wise consideration of the value of trees which led William Penn to prescribe, among the early laws of his colony, "that, in clearing the ground, care be taken to leave one acre of trees for every five acres cleared," has followed Michigan in the recent adoption of Arbor-day.

The older Northern and Eastern States have not the same interest in forestry as the prairie States. They are comparatively well-wooded. Yet, even among them, such have been the encroachments upon the woodlands by the axe and by fire as seriously to affect the flow of streams, and the manufacturing and agricultural interests dependent upon them. In several of these States attention has been called to the subject, and its manifest importance has led to legislative action looking to the protection of what forests remain and to the planting of new ones. Most of the New England States are now engaged in the serious investigation of their forestral condition. The boards of agriculture have taken it into consideration, and some of them have urged the adoption of Arbor-day as an instrumentality of importance to the interests of the States.

Thus the Arbor-day idea is seen to have spread far beyond the place of its origin. It has been formally adopted already by seventeen of our States, and bids fair to be adopted soon by many others.

A noticeable and important development of the Arbor-day movement is its connection with the public schools. This may be said to date from the memorable tree-planting by the pupils of the public schools of Cincinnati, on the occasion of the meeting of the American Forestry Congress in that city in the spring of 1882. No one who was present will ever forget the scene, when, on a lovely May day, twenty thousand school-children, marshaled by their teachers, formed a part of the grand procession which, amid banners fluttering from every window, and with the accompaniment of military battalions and bands of music, went out to the beautiful and well-named Eden Park, and there, in Authors' Grove, planted trees in memory of the most eminent authors and statesmen of our own and other lands. It was a lesson in practical forestry and of practical education at the same time. It was a grand and impressive object-lesson of the best character, and one that reached far beyond the circle of those immediately engaged in it. If the children were taken out among the trees for a holiday, the trees were thenceforth and thereby brought into the schools of Cincinnati, and the sweet influences of Nature connected with the school-room and its studies as never before. That holiday was made a most impressive and valuable school-day. It was for the time the school in the open air, face to face with Nature and her most healthful and instructive agencies.

It was only a little while after that scene in Cincinnati that the superintendent of the schools of West Virginia, moved alike by a desire to arouse a proper sentiment in behalf of forestry and to promote the interests of education, signalized his administration by designating an Arbor-day and inviting its special observance by the schools of the State. His appeal met a ready response, and the day was widely observed.

And by all means should Arbor-day invite the children to engage in its observance. It was a most happy thought to connect the schools with it and thus enlarge its scope. It was so, whether we consider the interests of forestry or the interests of education. The pupils in the schools to-day will soon be the men and women, the householders and citizens of the country, holding its character and destiny in their hands. They will be all-powerful. It is most important, therefore, that they should come into their influential place in society prepared to use their influence in the best manner and for the best ends. And this is to be secured by the best training in their school-days; such a training as will fit them to deal wisely with the facts and conditions of practical life. Their education should be so conducted as to be not a drudgery but a delight. And this it will be made, if the mind of the pupil is engaged with objects which interest it, with objects close about it, rather than those far away and with which it has no concern. Set the child to study the geography of his own town, or first his own school-house grounds, instead of that of Kamchatka, and he will be interested. Engage him in noticing the forms of the trees that grow about the school-place—the birds, the flowers, the rocks which he sees every day—and his mind will become all alive with interest in them. They are akin to his own nature. He lays hold of them as by an instinct. Give him these objects of study in place of much of the customary task-work of arithmetic and grammar, for instance, and you inspire within him such a loving and ardent desire of knowledge, and such an awakening of faculties, that the world around him will be his school-room so long as he lives, in which he will be studying to the last, and in which he will find perpetual delight. It is sad to know that so much of our school-time has been and still is wasted, and that the children so frequently have come out from the place of education, as it is called, with so little knowledge of the world in which they live and in which they are so soon to occupy positions of influence and responsibility.

There are no studies in which the young are so much interested as those which relate to the natural world, and there are none which better serve the purpose of disciplining the mind for the work of coming life. The general adoption of Arbor-day, therefore, and its connection with our schools would be a pleasant starting-point for the introduction into them of the natural sciences with all their healthful and helpful influences.

And just here, also, if we mistake not, is our best guarantee for the promotion of forestry and for the solution of a great national problem. The children, who have been invited and assisted to plant shrub and tree on their school-house grounds, will soon be interested in the work of their elders, as they plant trees along the borders of the streets, and will ask to join in it. Next, they will be ready to assist in bringing trees, with which it may be sought perhaps to give the village cemetery a more pleasant look; or they will enter with sympathy into the work of converting some neglected spot of ground into a comely park, or clearing up a rough piece of woodland so as to make it a desirable place of resort and recreation. Thus, going on from year to year, a new generation will soon have come to manhood and womanhood, a generation full of the love of trees as such, and not estimating them merely for their value as lumber or cord-wood. They will even have a poetic sensibility in respect to the trees. Like the old Greeks, they will sometimes people the woods and groves with dryads, or, as our ancestors did, with gnomes and sprites. They will have learned, also, as their fathers have not, the important relations which the forests sustain to climate, to the precipitation and distribution of moisture from the sky and clouds, and its exhalation from the ground. They will be sensible of their influence upon the hot and cold currents of the air, and their value to agriculture by serving as effective barriers against them. They will have learned, as their fathers have not, how nicely adjusted to each other are the forces of the natural world, and how hazardous it is to disturb their equilibrium, yet how easily in our ignorance or recklessness we may do it. The fact will be familiar to them that the woodman, by an improvident use of his axe upon the hill-side, may let loose the torrent or the avalanche, which may hurl ruin upon the fertile valley below. Well knowing these and many other things respecting the trees, of which the present generation for the most part are ignorant, or which they are slow to learn, the new generation will recognize, as we do not, that the trees are essential to man's highest welfare, that they are his best friends, that they are the constituted partners of the world with him, that human life in fact would be impossible without them. Recognizing these facts, as the new generation come into society as its directors, we may expect that they will be conservative of the forests, and thus conservative also of the best interests of the country.

SKETCH OF SIR JOHN BENNET LAWES.

In John Bennet Lawes, said "Nature," more than ten years ago (December 9, 1875), "we have a private individual who, unaided by the state, or by any scientific body, has made a greater number of useful experiments than all the experimental farms of European governments put together." The work referred to in such terms of praise was performed on Mr. Lawes's private estate at Rothamstead, in Hertfordshire, England, to which he succeeded as heir in 1822, being eight years of age, and on which he began his famous experiments in 1834, when he entered upon actual possession of it.

Mr. Lawes was born in 1814, and acquired his school education at Eton College and Brasenose, Oxford, where he was a student from 1832 to 1835. His favorite work during this time was in the laboratory; and after leaving the university he spent some time in London, in the study of practical chemistry. His situation and surroundings were particularly favorable to his giving his whole attention to the pursuit to which his tastes inclined him, and for which he had qualified himself by his studies. Possessed of independent means, a handsome property, and a beautiful old manor-house and domain of about five hundred acres, he at once interested himself in agriculture; and from the year he entered upon manhood till now, or for more than fifty years, he has been unceasingly applying his scientific knowledge to the solution of questions affecting the practice of that art. "In the commencement of his experiments," says his biographer in the London "Times," "among other subjects, the effect of bones as a manure on land occupied his attention for some time. A friend and neighbor, the then Lord Dacre, particularly directed his notice to the fact that bones were very variable in their effect on different soils. Several hundred experiments were accordingly made, some upon crops in the field and others with plants in pots, in which the constituents found in the ashes of plants as well as others were supplied in various states of combination. Striking results were gained from these experiments, in which the neutral phosphate of lime in bones, bone-ash, and apatite was rendered soluble by means of sulphuric acid, and the mixture applied for root-crops. The results obtained on a small scale in 1837–'39 were such as to lead to more extensive trials in the field in 1840–'41, and to the final taking out of a patent early in 1842. This being done, Mr. Lawes established large works in the neighborhood of London, for the manufacture of superphosphate of lime, by which name the manure is known, which has produced such a revolution in the science of agriculture."

In 1843 Mr. Lawes associated with himself Dr. J. H. Gilbert, whose name has since been connected with his in all the researches prosecuted at Rothamstead, as a practical chemist; and together they undertook a series of agricultural investigations in the field, the feeding-shed, and the laboratory. The laboratory was at first located in an old barn; but in 1854, when the friends of Mr. Lawes proposed to present him a service of plate in recognition of their appreciation of his work, he suggested that a new laboratory building would be a more appropriate and enduring as well as useful testimonial, and the money was applied for the purpose of erecting one.

The place, identified with Mr. Lawes's experiments, Rothamstead, the patrimonial estate of the investigator, is situated some twenty-five miles from London, in Herts, and is easily accessible to visitors from the Harpenden Railway station. The manor-house is described as being a remarkably fine specimen of Old English architecture, while the domain surrounding it contains some magnificent timber, including an avenue of lindens, which, for size and regularity of dimensions, are perhaps unsurpassed in the south of England. Around the family mansion lie the five hundred acres that form the experimental station, which is entirely maintained by Sir John. For the benefit of the large number of laborers whose services are required in the management of the station, Mr. Lawes many years ago formed an allotment club through which small gardens of about an eighth of an acre each can be rented. For this purpose, in 1882, sixteen acres of land had been allocated, and the whole number of allotment gardens then in cultivation was one hundred and seventy-four. The allotment area is furnished with a club-house.

The scientific discovery, says an English biographer, around which all Mr. Lawes's subsequent work centered was the disprovement of Liebig's mineral-ash theory. It was generally supposed at the time his experiments were begun that certain saline bodies, so-called mineral constituents, were essential to the growth and development of the plant, and that such substances must be furnished to it by the soil. The necessity of a certain quantity of nitrogen was recognized; but it was imagined, since wild plants could thrive without any artificial supply of nitrogen, that a sufficient amount of that element existed in the atmosphere to render it unnecessary to take any steps for increasing the supply. The cardinal discovery made by Mr. Lawes of the absolute necessity of the presence of nitrogen in the soil in order to maintain its fertility was a contradiction of this view, and led to the opening of a new field of agricultural investigation. In connection with the belief in the sufficiency of the atmospheric sources of nitrogen, it was supposed that the fertility of a soil might be maintained for an indefinite period if the different mineral constituents carried off by the crop were annually returned in due quantity as mineral manure to the soil. Respecting these two points, and regarding the sources of nitrogen, Mr. Lawes has said: "I maintain that the amount of nitrogen supplied to our crops from the atmosphere, whether as combined nitrogen brought down by rain or that absorbed by the soil or the plant, constitutes but a very small proportion of the total amount they assimilate, and that the soil itself (or manure) is practically the main source of their supply. Indeed, it is a question whether on arable land as much or more may not be lost by drainage or otherwise than is supplied by the atmosphere." The field experiments on which these conclusions rest have formed Sir John Lawes's principal work. Favored by position and circumstances, he has been enabled to carry out on a large scale most important operations. His general plan has been to select fields in a condition of agricultural exhaustion, that is, in a state in which a fresh supply of manure was needed to fit the soil for the growth of another crop. Upon this exhausted soil each of the most important crops in the rotation was grown year after year upon the same spot, in plots without manure, and in other plots in which various kinds of manure, but usually the same to each, were applied yearly. Thus it became possible to determine the point of relative exhaustion or excessive supply of any of the constituents of the manure. The details of this method are given an exemplary explanation in Mr. Lawes's "Report of Experiments on the Growth of Barley for Twenty Years on the Same Land," published in 1874, when the experiment was still in progress. The field had been divided into plots of about one fifth of an acre each. Some of these had never received any manure during the twenty years; the others received some one or more of the food constituents which barley requires. Thus, one was manured with phosphates, a second with alkalies, a third with ammonia, a fourth with ammonia and phosphates, a fifth with ammonia, phosphates, and alkalies, etc., every year in succession. At harvest the crops were carefully weighed, and were then analyzed in the laboratory under the superintendence of Dr. Gilbert, when the amounts of dry matter, ash, and nitrogen, were determined.

"The advantages of this systematic mode of experimenting," says an English review of the report, "are very great. Carried on in the same manner for so many years, these experiments answer questions relating to the exhaustion of the soil, to the permanent effect of manures, to the effect of season upon the produce. With the aid of the laboratory investigations they teach us what proportion of the various ingredients supplied in the manure is recovered in the crop, and how the composition of the plant is affected by the various conditions of the soil. In conjunction with analyses of the soil and of the drainage-water, we learn what becomes of the manures supplied, how deeply they have penetrated into the soil, what is the loss suffered through drainage, etc. A single field experiment, thus thoroughly and patiently carried out, touches half the domain of agricultural chemistry, and supplies information of the most solid and valuable kind."

Mr. Lawes addressed himself with great skill and success to the task of perfecting the methods of analysis; but, even after all his investigations, he believes that the elucidation of agricultural principles must be looked for from a due consideration of vegetable physiology as well as chemistry, and of the special functional peculiarities and resources of different plants as well as their actual percentage composition. The explanation of the distinctive functions of crops grown in rotation is found, in his view, in the character and length of life of the different plants; in the character of the roots in regard to number, size, etc., and to their aptitude to derive more of their food and moisture from the surface, or from the subsoil; and in the greater capacity of some for liberating and assimilating food not available for others, or for arresting food which would otherwise be washed out of the soil. In brief, his investigations have embraced researches into the exhaustion of soils, including experiments on crops; on the principles of rotation and fallow; on the mixed herbage of grass-lands; on the progress of vegetation generally, including researches on the action of manures; on the origin of nitrogen in plants; on the feeding and fattening of cattle, and generally on stock as meat-producing and manure-making machines; on rainfall and drainage; on botanical characteristics; and on the chemistry of the malting process, and the comparative value of malt and barley as food for cattle. Mr. Lawes also, in conjunction with Professor Way, acted upon a royal commission from 1857 to 1865, in the investigation of the effect of the application of town sewage upon grass and other crops; and in the institution of comparative experiments on the feeding qualities of the differently grown crops, to be determined by the amount of increase yielded by oxen, and the amount and composition of the milk yielded by cows.

In 1872 Mr. Lawes announced his intention of placing in trust his laboratory and experimental fields, with an endowment of £100,000, the interest of which, after his death, should be applied to the continuance of the investigations carried on there. "It is seldom," "Nature" remarked, in noticing the fact at the time, "that we have to record an act of so great munificence directed in a channel calculated to bring about such important results to the scientific departments of agriculture."

Mr. Lawes was elected in 1854 a Fellow of the Royal Society, whose royal medal he received conjointly with Dr. Gilbert in 1867; he has also received a gold medal from the Imperial Agricultural Society of Russia; in June, 1881, the Emperor of Germany by imperial decree awarded the gold medal of merit for agriculture to him and Dr. Gilbert jointly, in recognition of their services for the development of scientific and practical agriculture; and in May, 1882, Mr. Lawes was created a baronet, and became Sir John Bennet Lawes. He is also a Fellow of the Chemical Society, and an LL. D.

The results of the Rothamstead investigations of Sir John Lawes are to be found in the journals of the Royal Agricultural Society, the reports of the British Association, the Journal of the Chemical Society of London, the Transactions of the Royal Society, the Journal of the Society of Arts, the Journal of the Horticultural Society of London, the "Edinburgh Veterinary Review," the reports of the Royal Dublin Society, the "Philosophical Magazine," the "Agricultural Gazette," the "Chemical News," and in official reports and scattered pamphlets and newspaper letters.

Of the value of Sir John Lawes's work at Rothamstead as a whole, we find the judgments recorded in scientific reviews of its results, that "it is not to be equaled by that of any of the foreign stations; indeed, in several departments of investigation it might safely challenge comparison with their united efforts"; and that "he has obtained a larger body of facts in relation to manures and cropping, and the feeding of animals, than all the agricultural societies in the empire put together."

We also find some lessons suggested by it in the same reviews, the bearing of which seems to have escaped the notice of the reviewers themselves, for they forthwith proceed to draw from them the opposite conclusions to the true one: "The whole is the work of the man himself. He has had no aid from the Government or any agricultural society, and no advice from any committee or public body." "Of the indebtedness of science to Mr. Lawes's unique and costly experiments we need not speak, the facts are so plain that they speak for themselves. Nor need we state the moral. The addition to the national wealth which has accrued from the discoveries made by Mr. Lawes is already enormous. It must be borne in mind that this benefit has arisen from *accidental* researches, for Mr. Lawes was not compelled to take them up, nor is he bound to continue them."

The secret of this great merit is also given; for while Mr. Lawes has not had an unqualified success, especially in drawing inferences from his facts, "his writings afford ample evidence of great earnestness of purpose. His manly, outspoken language shows that he loves truth for its own sake. He has had ample resources; and he has had the motive of self-interest, as well as love of knowledge, to stimulate him in his investigations."

In this splendid example, as in so many others, we have illustrated anew the fact that the best scientific results and the most important advances in discovery are the fruit of earnest individual work, prompted by love of the pursuit and carried on in a spirit of self-reliance; that investigation can and will make its own paths and find its way to its own ends, and be more vigorous and active for the effort; and that the time has not yet come when, in Anglo-Saxon countries, science has so declined that it must be coddled by official patronage.

EDITOR'S TABLE.

A CASE IN MORAL EDUCATION.

IT is encouraging to observe, by the recent discussions in Congress, that there is a deepening conviction of the need of an international copyright law to put a stop to the scandalous robbery of those foreign authors who are doing so much to sustain and elevate our intellectual life. There are evinced a growing sense of reprobation of this practice, and much greater agreement than ever before, both as to the necessity of putting an end to it, and the means to be adopted for the purpose. The committee was addressed by but one downright opponent of international copyright, and he admitted that he was opposed to all copyright, and would take away the legal protection of their literary property from American authors. Mr. James Russell Lowell, President of the Copyright League, made an excellent address, putting the whole question on the high moral ground of the rights of men to property in their brain-work, and the outrage of allowing other men to appropriate it from mercenary motives and because they find it valuable; and he did not hesitate to say that the reasoning by which international copyright was there opposed was but a virtual defense of pocket-picking. We call attention to this matter here simply to show that there is an undoubted quickening of the moral sense of the community over this question, so that what was long regarded with indifference as but a venial wrong is now reprobated as a practice so bad that it can be no longer tolerated.

And even while the question is being thus debated, there comes a fresh and flagrant instance of that spoliation of foreign authors which will continue to be perpetrated until the law lays its hand upon men destitute of any restraining moral sense. The case is peculiarly aggravated in this respect. A foreign author writes a valuable book, which is found especially useful in this country for cultivating the minds of teachers; and their sense of obligation to him for his great service is expressed by a virtual conspiracy among them to steal it. Mr. James Sully, of London, is the author of the "Outlines of Psychology." The work was created by his labor. It was made at the cost of time, faculty, and blood; he consumed his vital energy in preparing it just as much as is done in producing any other piece of work of any kind that was ever constructed. If there be such a thing as property, Mr. Sully's book was his property by every principle of justice and right. That was recognized by his American publishers, who made an arrangement with him to pay a royalty on the sales at an equal rate that it is customary to pay American authors. The arrangement was doubly valid in the eyes of all honorable men, for it was intrinsically just and equitable and was voluntarily made without any compulsion of law.

Mr. Sully's work was a large textbook of general psychology, but it gave prominence to the bearings of that science upon theoretical and practical education, and this was the feature that was specially appreciated by our educators. It was an obvious suggestion that to separate the educational part of the book from its connections and issue it separately in a cheaper form would be a desirable thing. Different parties, in fact, applied to the publishers to get the job of cutting the book down; but they answered that this was a matter belonging entirely to the author. He was written to, and, approving the plan, engaged to make a compend of his work for the use of teachers and to do it at once; and it was widely advertised by the American publishers that an authoritative abridgment of the "Outlines of Psychology" by the author himself would soon appear. It need hardly be said that the author, who knew the subject thoroughly, and had created the work, was the most competent man to prepare from it a briefer volume, which would require much adaptation and new statement; because justice to teachers and to a most important subject could not be done by merely ripping out mechanically a part of the larger book and printing it separately. But Principal Reinhart, of the Paterson High-School, paid no attention to any such consideration. He cut out what he wanted from the volume, added some notes, and applied to Messrs. Appleton to print it, which of course they declined to do; and he then found another publisher to carry out his very questionable project.

Now, our only concern here is with the moral complexion of this affair, in connection with what goes for "higher education" in the public-school system of this country. A great deal is said about the low state of moral education in our public schools; but the grave question arises as to the competency of the directors of even our "high-schools" to teach it. Moral education is a matter of principles applied to practice; it inquires into the grounds of right and wrong in conduct, with a view of determining what things are proper to do and what are forbidden as immoral or unjust. It aims simply to ascertain and enforce upon the individual right rules for the guidance of personal action in daily and practical life. The obligations of morality are clear enough; what is wanted in the schools is the explanation of their fundamental importance, their sacredness, the sophistry by which they are evaded, and their pointed application to the conscience of the young.

Is the Principal of the Paterson High-School, a fit person to give such instruction? Could he explain to his classes the moral difference between stealing Mr. Sully's book and stealing his watch? Could he explain to his Jersey students why they should not steal the paper and binding of Bardeen's volume as he has its contents? If he should say to them that paper, ink, and binding are sacred things and not to be appropriated without payment, while the soul of the work, the part sought and prized as a power in our education, has no value which he is bound to recognize, would they not be justified in replying to the argument by throwing the book at his head? The Principal of a high-school who, at this time, will appropriate literary property which he has no moral right to touch, who will rob an author simply because he is helpless and must intrust his book to the public honor, and who will mutilate a work which he knows the author is himself revising and making over for the specific objects recognized—such a Principal may comply with the State standard of competency to control a high-school, but, in our opinion, he is not fit to give instructions in moral education.

The Paterson Principal will, of course, have his excuses. He may say: "The appropriation of foreign books is a common thing; it is done, and has been long done, by respectable people; I am no worse than they are." But this will not do. When a professional literary freebooter says: "I care nothing for the rights of foreign authors; I propose to take their works as long as I can profit by them and keep out of jail; 'what are you going to do about it?'"—his case is not a proper precedent for the principal of a high-school charged with the duty of forming the moral characters of pupils committed to his charge. He is to teach them that what is intrinsically wrong is not made anything else because others indulge in it. Of course, he can quote many bad examples which he has followed, but he is among those who pre-eminently have no business to follow bad examples, either in practice or in precept. But the Paterson Principal will search a long time before finding a precedent as bad as that which he himself has set. He goes voluntarily into the business of robbing foreign authors when nearly everybody else is trying to stop it; he cuts up his book at his own caprice while the author is himself revising and condensing it; and then he plots with other educators to secure the adoption of the dishonest edition, to the exclusion of the honest and superior book. Such things might be expected of a sordid and unprincipled huckster in the publication business, but they are to be reprobated in the principal of a high-school. That he is backed by other teachers does not help the matter, but only still further exemplifies the lax and dull state of mind in regard to right and wrong which they thus evince, and which goes far to explain the backwardness and neglect of moral education in our schools.

STABILITY IN SYSTEMS OF THOUGHT.

In the "Commercial Advertiser" of January 14th there is an able article, evidently from the master-mind of that journal, on Spencer's evolution philosophy, which, from the interest of the questions raised, as well as its very decided views, deserves some critical notice. After passing encomiums on Mr. Spencer for his noble and disinterested aims, the comprehensiveness of his work, his immense results considered as an intellectual achievement, his painstaking industry, and indefatigable persistency of purpose, the writer remarks that, admirable as it all is, it still has about it "a touch of the pathetic." Not that it may never be finished, as many fear, but that, even if completed, it will quickly take its place among the systems of futile speculation with which the human mind has teemed for these thousands of years. After referring to the sad experience of Buckle, the writer says: "Mr. Spencer's case is different; he may be able to finish his work, but the view of it that comes to us is, that when it is finished it may prove, in scope and substance, no more than a brilliant dream. The theory of evolution, in the construction of which he has spent so many laborious days and nights, lavished such wonderful powers of observation and generalization, and exhibited such an ingenuity of fancy, collecting such masses of knowledge and scintillating such flashes of suggestion, will, after all, share the fate of other merely speculative fabrics, and, like them, in spite of a certain color of science which he has been enabled to give it, fade away in the advancing light of real knowledge."

We can not help thinking that this judgment manifests an imperfect appreciation of the intellectual revolution which marks off ancient and mediæval from modern thought, in so far as this represents a new era of science. It can hardly be contended that science in the present state of its development counts for nothing in its influence upon systems of thought; nor is it difficult to see in what way it acts and must increasingly act in future to discredit or to conserve such systems. The old schemes of speculation and schools of philosophy ran their transient course under the influence of great teachers, and then declined and gave place to others, because they had no basis in any real knowledge of Nature. In metaphysics and religion, the two great spheres of mental activity, imagination went riot for lack of restraining data. They had no element that could give them permanent value; one man's opinion was as good as another's, and systems multiplied with the common and inevitable character of instability. Some were preserved by favoring accidents. The system of Plato, as intrinsically worthless as the rest, lived on as a power in the world of thought because of the ingenuity of his speculations, the impressive beauty of their literary forms, the vitality of classical superstition in later ages, and because his system of ideas has been supposed to favor the fundamental beliefs of Christian theology.

But modern thought made a new starting-point when it began formally to build on the verities of Nature. A new element was then introduced into philosophy which was capable of giving it permanence. The discovery of the laws of motion, for example, was an intellectual acquisition to stand forever. When it was proved that the earth is not the stationary center of the universe, but only a revolving planet, there was given, not only a new fact for all time, but a fact that shattered whole systems of pre-existing opinion, and became a permanent element to fix and regulate the future thinking of mankind. In further instance, the discoveries of the circulation of the blood, of the laws of nutrition, of the double action and reflex functions of the nervous system, revealed facts of enduring moment which threw new light upon the nature of man. The establishment of the indestructibility of matter, and that all mutations of material things are governed by this law, was a new key to the understanding of our world which can never be lost. And when the kindred truth of the conservation of energy, or that in the known course of Nature force is never created or destroyed—which Faraday pronounced to be "the highest law in physical science that our faculties permit us to perceive"– when this mighty principle was demonstrated, whole systems of speculation were undermined, whole realms of previous error were destroyed, and the philosophical interpretation of Nature was put upon a new and indestructible basis. We have given a few illustrations of that element which it was the destiny of science to contribute, and by which it has formed a new epoch of thought; but all the sciences are full of this new element. It consists of contributions of fact and law standing in everlasting contrast with the baseless and transient assumptions of philosophers for the past two thousand years. But the two thousand years of empty philosophical speculation got a mighty headway; and, as our education is still dominated by tradition, the cultivated mind of the age, saturated with the "history of philosophy," remains blinded to the profound significance of that revolution of ideas which modern science has introduced. There are plenty of men whose culture is so full of the past that they are sure to go on spinning systems fanciful and futile as their predecessors; but such work is certain to become more and more anomalous and less and less regarded. For, with the development of science, there has come a new mental culture. Science forms habits of thought. Pursued in its true spirit it enforces a special discipline in the study of truth. It corrects credulity by a wholesome skepticism; it affirms the supremacy of personal observation, and demands caution in forming conclusions. All these requirements are repressive of that wanton exuberance of imaginative invention in which speculative genius is so prone to indulge. The system-maker of these times must *know* something, must build upon previous acquisitions, or he will neither be listened to by the present nor have a hold upon the future. The rapid growth of science in these days proves that its education and its disciplines have not been without effect, and it is not to be questioned that its method is gradually extending into all the spheres of mental activity. There is here a new element of stability in intellectual constructions of which nothing was known in all the historic epochs of speculation.

The writer in the "Commercial"

says that the theory of evolution which Mr. Spencer has elaborated with such ingenuity "will share the fate of other merely speculative fabrics," and "fade away in the advancing light of real knowledge." The implication of course is that Mr. Spencer's work lacks the character of "real knowledge," and this the writer confirms by speaking of "a certain color of science" which he has been enabled to give it. This is a strange deliverance. A system born of science, and constructed warp and woof out of the accredited facts and truths of the sciences, is not well described as having imparted to it a superficial coloring of science. Mr. Spencer's allegiance to facts, his comprehensive grasp of the results of science, and his command of the scientific method and fidelity to it, are unchallenged. His system, given out in fragments favorable for the most critical examination, has been under fire for twenty-five years, and has extended in influence and steadily risen in consideration in a scientific age because it was recognized to embody more "real knowledge" than any other such system ever before presented. The writer in the "Commercial" thinks he sees indications that it is already declining; he merely misinterprets the subsidence of opposition.

The simple fact of the case is, that Mr. Spencer was the first to deal with evolution as a strictly scientific problem. He withdrew it from the field of fanciful speculation, and subjected its investigation to the rigorous conditions of analytic and synthetic science. The time had come when, by the laws of advancing intelligence, the subject had to be taken up from this point of view. Its fundamental datum was given by Huxley in a few words. "It is now established, and generally recognized," said he, "that this universe and all that it contains did not come into existence in the condition in which we now see it, nor in anything like that condition." It is therefore self-evident that changes have taken place by which one condition of things has led to another and a different condition of things. Mr. Spencer took up the inquiry at this point by asking, What are the laws of these changes? It was an inquiry into the order of the phenomenal world and therefore strictly scientific in its nature, as not a step could be taken toward its solution except by the inexorable application of scientific methods. Postulating those universal and fundamental laws of scientific inquiry, the indestructibility of matter and force, the changes that have taken place had to be investigated as transformations by which one thing is derived from another, and the present evolved out of the past under that inflexible principle of all scientific inquiry, the law of cause and effect. Beyond doubt, one of the great secrets of the rapid acceptance of the doctrine of evolution by the best-trained minds of the age is the thoroughly scientific character of the exposition in Spencer's system. It has the stability of a great law of Nature, fortified by results from all the sciences, and can only pass away as it is further developed under the principle of evolution, which itself gives law to the progress of knowledge; and the attempt to kick it into the limbo of speculative vagaries implies, as we have said, some considerable misapprehension of the situation.

LITERARY NOTICES.

Gray's Botanical Text-Book. Sixth edition. Vol. II. Physiological Botany. 1. Outlines of the Histology of Phanerogamous Plants; 2. Vegetable Physiology. By George Lincoln Goodale, A. M., M. D., Professor of Botany in Harvard University. New York and Chicago: Ivison, Blakeman, Taylor & Co. Price, $2.

The first edition of Gray's "Botanical Text-Book" was published forty-three years ago, and took the highest rank at once as an American exposition of the science, both for college uses and for students generally.

With the rapid development of the science successive editions appeared, each for the most part rewritten, the fifth edition coming out in 1857. But botanical science at length outgrew the possibility of dealing with it in any adequate way in a single volume. This led to the necessity of completer treatment in several connected works. Professor Gray says in his preface: "To secure the requisite fullness of treatment of the whole range of subjects it has been decided to divide the work into distinct volumes, each a treatise by itself, which may be independently used, while the whole will compose a comprehensive botanical course."

The first volume of this series was written by Professor Gray, and entitled "The Structural and Morphological Botany of Phanerogamous Plants." It deals chiefly with organography, or the account of the structures and forms of the organs of plants, and, as the author remarks, "should thoroughly equip a botanist for the scientific prosecution of systematic botany, and furnish needful preparation to those who proceed to the study of vegetable physiology and anatomy, and to the wide and varied departments of cryptogamic botany" which are to be dealt with in the subsequent volumes of the series.

The second volume of this work upon "Physiological Botany" (vegetable histology and physiology), the treatise now before us, was written by Professor Goodale, the colleague of Professor Gray, and Professor of Botany in Harvard University, and is "devoted to a consideration of the microscopic structure, the development, and the functions of flowering plants; that is, to their vegetable histology, organogeny, and physiology." The volume is divided into two parts, the first taking up and pursuing with great thoroughness the subject of histology, or the minute microscopical structure and elements of plants. An introduction is devoted to "Histological Appliances," or the instruments of the botanical investigator—such as microscopes, dissecting implements, reagents, etc. Cells and tissues, in their structures, contents, compositions, and modifications, are then taken up in a general way, to be followed by the minute structure and development of root, stem, and leaf, flower, fruit, and seed. Elementary structures being mastered, the pupil then proceeds, in Part II, to the investigation of their functions, or physiological botany proper. Physiology considers the plant in action, the changes occurring in its multitudinous parts, the constituents involved, the products generated, the interactions of the vegetable organism with soil and air, the movements of plants, vegetable growth, germination, and reproduction.

What chiefly strikes us, in looking over this interesting volume, is the immense advance that has been made in late years in the elucidation of the laws of the internal vegetable economy. There has been a large increase in the resources of investigation, the skillful experience with which it is conducted, and a great amount of new light has been thrown upon the obscure and subtile processes of vegetable organisms. Vegetable physiology has been brought far more completely within the grasp of the experimental method than would have been thought possible thirty years ago. It has become laboratory-work, as established and necessary as in the case of chemistry or physics. It follows from this that to the thorough study of physiological botany not only microscopical observation but manipulatory exercises of various kinds are quite indispensable. It was formerly supposed that the physiology of plants was a subject to be mainly read about, and the knowledge of it derived from books, without much possibility of a direct and real acquaintance with the facts, but that view must now be abandoned. We observe with interest and great satisfaction that Professor Goodale has been fully alive to the educational implications of this circumstance, and has made his volume a working text-book by which the student is enabled and required to make the knowledge of the subject his own. Those who faithfully go through the work will not only acquire a mastery of the facts, and a thorough acquaintance with what is known of the processes of vegetal life, but they will gain a valuable training in the conditions of scientific method and the difficult and important art of scientific investigation.

We can not close this slight and very unsatisfactory notice of a most important book without some cordial recognition of the obligations of American scientific men and American teachers to the life-long and invaluable services of Professor Gray in the elaborate revision of his text-books which have now taken so comprehensive and complete a form in this series. With the patience and perseverance of the true scientific enthusiast, he has confined himself to his own line of work, and taken authoritative possession of the botanical field in this country. By securing the co-operation of other men whom he has assisted to qualify for the work, Professor Gray gives to his undertaking a solid and permanent value which will make it influential upon the growth of American botany for many years to come.

French Dishes for American Tables. By Pierre Caron (formerly *chef d'entremets* at Delmonico's). Translated by Mrs. Frederic Sherman. Pp. 231. D. Appleton & Co. Price, $1.

This may not be "the cook-book of the future," but, what is more to the purpose, it is a pretty good cook-book for the present. Written by a man and translated by a woman, it ought to be full of the duplexcellences implied by its double origin. At any rate, the man understood the business of cooking, and the woman understands the business of translation; and so the man's full and accurate knowledge of culinary operations is made as simple and clear to the reader as plain, well-chosen language can make it. The book contains six hundred receipts, and it is said the quantities are all calculated for tables of eight persons. We have heard that this book has been tried with marked success.

Railroad Transportation: Its History and Laws. By Arthur T. Hadley, Commissioner of Labor Statistics of the State of Connecticut, Instructor in Political Science in Yale College. Pp. 269. New York: G. P. Putnam's Sons. Price, $1.50.

The laying down of an iron track on leveled ground, whereby vehicles could carry heavier loads, and the attachment of steam-machines instead of animals to draw the vehicles were mechanical novelties in their time which many could not fail to see were full of new possibilities, but nobody even suspected the tremendous implications of the steps that had been taken. He who saw the first car moved by steam upon a tramway, and hauling a load of stone, may also have lived to see an express train of palace-cars, with a meeting-house full of people, shooting along with the proverbial swiftness of the pigeon, "a mile a minute." This result shows the astonishing rapidity of the development of the art of locomotion, and always impresses the observer with wonder at the triumphs of invention, and the new conquest over space and time that may be shared by everybody.

And yet all this is but the superficial aspect of the railroad dispensation upon which we have entered. The discovery has been gradually made that the railroad system is a new social power, the destiny of which is to force to such a solution as they may be capable of receiving a large number of fundamental questions relating to industry, commerce, the laws of competition, individual rights and corporate prerogatives, the operation of natural laws in society, and the compass and limitations of legislative authority. These problems are forced upon the community by the development of railroads, as they could have been in no other way. They *must* be met and acted upon, if not with far-seeing intelligence, then with short-sighted ignorance; and as the results of experience disclose themselves—good or bad—we shall have a large and instructive example of that compulsory education which originates in social conditions and the nature of things.

It is somewhat from this point of view that the timely and admirable book of Professor Hadley has been prepared. It is not at all a treatise on the railroad in itself, and is not to be ranked with books of construction, improvement, and railway management that are made for the uses of railroad-men. It is rather a book on the *relations* of railroads to the community, and therefore deals with a class of subjects in which all citizens are interested. The writer's point of view is thus briefly indicated in his preface: "This book deals with those questions of railroad history and management which have become matters of public concern. It aims to do two things: first, to present clearly the more important facts of American railroad business, and explain the principles involved; second, to compare the railroad legislation of different countries, and the results achieved. The two things need to be viewed in connection with one another. The attempt to manage railroads without regard to the demands of public policy, or to legislate concerning railroads without regard to the necessities of railroad business, results in disastrous failure. This fact has been gradually recognized by thoughtful men on both sides."

To meet this view of the subject, Professor Hadley has written his volume, which, for popular use, is beyond comparison the most instructive and valuable railroad-book that we have seen. It is a work which ought to be very generally read; for there is a great deal of ignorance, prejudice, and passion among many people in regard to railroad management, which would be dispelled if the matter were better understood—a result to which the perusal of this volume will certainly lead. The author writes neither in the blind interest of railroad corporations, nor of the people as a class victimized by these corporations, but in the light of facts and principles to which both must bow. It may be added that the volume is one that will be read with much pleasure, from the freshness and variety of its information on the latest results of railroad experience.

The Philosophy of Education: or, The Principles and Practice of Teaching. By T. Tait, F. R. A. S. Pp. 331. New York: E. Kellogg & Co. Price, $1.

This seems to be a kind of general treatise on the art and mystery of school-keeping, and was evidently reprinted, as the editor intimates, because of "the growing desire for treatises on education." It contains a great deal of information about schools and teaching, and various parts of it will prove suggestive and useful, but it is a good deal behind the age. Originally published in 1837, it represents the state of thought in the early part of the century; and its psychology, the vital point in any educational work that proposes to deal with principles, is completely outgrown and discredited, as editor Traub acknowledges. But, after all, most teachers, notwithstanding all the progressive talk about psychology, are still deep in the old dispensation of "mental philosophy," and will therefore find themselves much at home with this volume.

Rational Communism. The Present and Future Republic of North America. By a Capitalist. New York: The Social Science Publishing Company. Pp. 498. Price, $1.50.

The capitalist author presents in this work a plea and a scheme for a new social organization. His ideas are said to be the outgrowth of a vision, in which, lifted high in the air, he saw New York, Brooklyn, Long Island, etc., newly laid out and peopled on an ideal plan adapted to promote the equal wealth, standing, and happiness of all. Coming back to the reality, he finds things organized to promote inequality and not happiness. He then proceeds to develop his plan, in which he aims to avoid the particular rocks on which all the social communities hitherto projected in this country have been severally wrecked.

The Will: A Novel. By Ernst Eckstein, author of "Quintus Claudius," etc. From the German by Clara Bell. Authorized edition. In two volumes. New York: Gottsberger.

The will here intended is not that mental element sometimes known as volition, but a document of an entirely material nature, which meant not only fortune to the hero of the story but name and titles as well. Like so many other modern novels, the tale winds in and out among socialists and their doings and beliefs, although it can scarcely be called a partisan book. The attempt seems to have been expository of the workings of that order of beliefs and feelings, which seems to lend itself to dramatic treatment with as remarkable success as the grand passion itself.

On the Heating and Ventilation of Dwellings and School-rooms. By Charles O. Curtman, M. D., St. Louis. Pp. 10.

This is a reproduction of a paper that was read before the American Public Health Association. It presents a careful review, with suitable illustrations, of the operation, merits, and demerits of all the methods of house-heating in current use, with especial reference to their adaptability to school-rooms.

Joint-Diseases: Treatment by Rest and Fixation. Pp. 15. Surgical Treatment of Infants. Pp. 12. By De Forest Willard, M. D. Philadelphia.

Dr. Willard holds that rest subdues joint-inflammation more effectually than all other means combined, and that the more perfect the rest the greater will be the diminution of pressure, tension, and inflammation, and of their resultant ankylosis and suppuration. The pamphlet contains the arguments in support of his views and descriptions of the appliances, and their applications, by which he secures the rest he prescribes.

The second paper is an address which was read in June of last year before the Philadelphia Obstetrical Society. The author believes that the surgery of childhood, as compared with that of adult life, is, aside even from congenital defects, sufficiently marked and distinctive to entitle it to separate consideration. Even the anatomy of the child can not be learned from the ordinary adult dissections during a college course, but the surgeon must make himself specially acquainted with it. References are made, in the course of the address, to classes of cases in which special treatment and applications may be called for.

The Prehistoric Palace of the Kings of Tiryns. By Dr. Henry Schliemann. New York: Charles Scribner's Sons. Pp. 385, with Chromo-lithographic Plates, Map, and Plans. Price, $10.

The citadel of Tiryns is one of the most ancient ruins in Europe. The city which it represents had its origin and probably its whole existence in prehistoric times. It is treated in Homer's "Iliad" as a place whose greatness was of the past, while Mycenæ was still vigorous and Argos rising. Its massive remains or "cyclopean walls," standing some eighty feet above the sea back of the Gulf of Nauplia, were regarded as a miracle in ancient days, and have been objects of wonder to Greeks, Romans, and moderns, for twenty-five hundred years. Dr. Schliemann having attacked, with more or less of satisfaction in the result, Troy, Mycenæ, and Orchomenos, it was natural that the attention of the great archæologist should be directed to their rival in antiquity and in association with the legends of the heroic age. His work at Tiryns has been rather more successful than at the other places he has explored, because he has gone at it with the benefit of acquired experience, and has been able to perform it more systematically and in such a way as to insure the preservation of everything. He has laid bare the whole plan of the palace and fortress, with all of its most important details, and has given the means for forming a clear idea of how those Herakleid or Perseid Greeks lived. The palace was reached by a winding carriage-way duly guarded with gates, the thresholds, bolt-holes, and pivotal hinge-holes of which, and the ashes of the wooden parts, are still visible. The plan of the palace was elaborate, and reveals a grouping around two centers, the hall of the men and the hall of the women, communication between which was only indirect. The walls were adorned with paintings in animal and geometrical designs, and plaques of alabaster with designs in blue-glass paste, fac-similes of which are given in the colored plates of the book. One of the most remarkable features of the building was the bath-room, which was floored with a single slab of stone of eight by ten feet, that can not weigh less than nineteen tons. Within this room was found a fragment of the terra-cotta tub in which the heroes took their baths. The arrangements for drainage and the whole plan of the palace show a considerable advance in civilization, when, as we have been accustomed to believe, civilization had hardly begun on that spot. The excavations, to which Dr. Schliemann had given his personal attention, were continued while he was preparing his account, during 1885, by his collaborator, the distinguished German archæologist, Dr. William Dorpfeld. He made a series of new discoveries hardly less interesting than those which had already been made. Among them are the facts that the huge stones of which the walls were built were not absolutely rude, but were roughly hewed and shaped for their purpose; that the walls were built with clay mortar, which has been washed away in all the exposed portions; and that these walls, which are of great thickness, have chambers within them to which access was had by galleries, the use of which had previously been a puzzle to the explorers. We have also in Professor F. Adler's preface, in which the writer makes comparisons between the ruins of Tiryns and other monuments of prehistoric Greece, and deduces the significance in some points of the whole, a few suggestions which open to us new conceptions of the capacity and arts of the heroes. Many of the blocks of the upper citadel must weigh from 12,000 to 15,000 kilogrammes—even middle-sized stones weigh from 3,700 to 4,000 kilogrammes—and their transport, to their exact place on a high and rocky site, was only possible with the aid of many technical devices and a host of workmen. These figures prove that the citadel can not have been built in a hurry, in the sight of an enemy, or as the first stronghold of an invasion based on maritime supremacy. In fact, "the colossal walls tell every one able to read the language of stones that their erection can only have been effected in a long period of peace, by a ruler with unusual sources of power, and who had trained workmen under his permanent control." There are other facts that point to these buildings being second structures on the site; and, reviewing all the sites, "a real primitive architecture is nowhere to be found; even in Troy the first steps of development are long past. Within certain limits, the materials are already under control, and worked variously, according to the available means and the ends required. A moderate but yet very fruitful store of detail forms is already gathered, so as to cover the gradually elaborated shapes of rooms with significant adornments full of meaning. In some peculiarly favored places, the domain of the higher monumental architecture has already been entered upon with decisive success. In the face of such extended and yet closely connected achievements, which form a consistent whole, the attempt to search for the roots from which arose this early bloom of the art of building is doubly attractive." Other suggestions may be found relative to the development of forms of architecture in stone from models afforded by the primitive wooden structures, and to the connection of this early European with already old Egyptian art.

Brain-Rest. By J. Leonard Corning, M. D. Second edition. New York: G. P. Putnam's Sons.

This little book, which may be regarded as a supplement to the same author's treatise on "Brain Exhaustion," published by D. Appleton & Co., and already noticed in the "Monthly," deals with the important question of the reinvigoration of the brain after exhausting mental labor or after disease. Dr. Corning has made a special study of the subject, and his book contains many facts and suggestions which brain-workers may find of service, and by the help of which they may be able to avoid or remedy to some extent the great danger to which their method of life exposes them.

Report of the Committee of the Citizens' Association on the Main Drainage and Water-Supply of Chicago. J. C. Ambler, Secretary: Rooms, 35 Merchants' Building, Chicago. Pp. 32.

The report shows that the water-supply from the lake is always liable to contamination from sewage entering the lake anywhere within the present district. Hence, all sewage whatsoever in this district should be diverted from the lake as its outfall. The flood-waters of the Desplaines and the North Branch may be diverted to the lake north of this district, or through Lake View township, and the South Fork may be connected with the lake by a conduit. But the main reliance for drainage should be by conveyance to the Illinois River. The general plan suggested by the committee may be carried out step by step, to the gradual improvement of the sanitary condition, and without creating a debt or requiring an extraordinary tax-levy.

National Conference of State Boards of Health. J. N. McCormack, of Kentucky, Secretary. Pp. 63.

This pamphlet, which is a reprint from the Report of the Illinois State Board of Health for 1885, contains an account of the organization of the Conference in connection with the meeting of the American Public Health Association at Detroit, Michigan, in November, 1883, and the reports of its first meeting at St. Louis, in October, and the adjourned meeting, at Washington, in December, 1884.

The Annals of the Cakchiquels. The Original Text, with a Translation, Notes, and Introduction. By Daniel G. Brinton, M.D. Philadelphia. Pp. 234. Price, $3.

This is the sixth volume of Dr. Brinton's "Library of Aboriginal American Literature." In the editor's estimation, on account of both its historical and linguistic merits, the document which it presents is one of the most important in the class to which it belongs. "Written by a native who had grown to adult years before the whites penetrated to his ancestral home, himself a member of the ruling family of one of the most civilized nations of the continent and intimately acquainted with its traditions, the work displays the language in its pure original form, and also preserves the tribal history and a part of its mythology, as they were current before they were in the least affected by European influences." The translation is made directly from the orignail text. The Cakchiquels were a nation of somewhat advanced culture, who lived within the area of the present state of Guatemala, and spoke a language related to the Maya. They were agriculturists and skillful builders, and had a picture-writing. The present work takes up the history of the tribe during the latter part of the fourteenth century, and brings it down to about 1559. It was introduced to public notice by the Abbé Brasseur de Bourbourg, and Dr. Brinton's translation is made from his copy.

Third Annual Report of the Bureau of Ethnology, 1881–'82. By J. W. Powell, Director. Washington: Government Printing-Office. Pp. 606, with Plates.

The plan of the work of the Bureau of Ethnology, of which this volume covers one year, contemplates the direct employment of scholars and specialists to conduct investigations and prepare the results for publication; and the stimulation and guidance of research by collaborators who voluntarily contribute the results of their work for publication or other use. Papers were published during the year covered by the report in Volume V, of "Contributions to North American Ethnology," on cup-shaped and other lapidary sculptures, "Prehistoric Trepanning and Cranial Amulets," and the Maya (Yucatan) "Manuscript Troano." The field-work of the year embraced the researches of Mr. Cushing among the Zuñis, with the labors of other observers in that tribe and among the Pueblos; researches by Mr. Gatschet among the Katábas in South Carolina, Mrs. Erminnie A. Smith among the Iroquois, Dr. W. J. Hoffman among the Indians at Fort Berthold, Dakota; and "Mound Explorations." Subjects bearing upon linguistics and related branches have been studied and elaborated in the office of the Bureau. In the present volume are included as "accompanying papers," and constituting the greater part of its bulk, "Notes on Certain Maya and Mexican Manuscripts," by Cyrus Thomas; "Masks, Labrets, and Certain Aboriginal Customs," by William H. Dall; "Omaha Sociology," by J. Owen Dorsey; "Navajo Weavers," by Dr. Washington Matthews; "Prehistoric Textile Fabrics of the United States, derived from Impressions on Pottery," by W. H. Holmes; and catalogues of two collections—one from mounds and one from Arizona and New Mexico—made during 1881.

Modern Molding and Pattern-making. By Joseph P. Mullin, M. E. New York: D. Van Nostrand. Pp. 257.

This is designed to be a practical treatise on pattern-shop and foundry wo k, and embraces the molding of pulleys, spur-gears, worm-gears, balance-wheels, stationary engines, and locomotive cylinders, globe-valves, tool-work, mining machinery, screw-propellers, pattern-shop machinery, and the latest improvements in English and American cupolas, together with rules and tables for every-day use. Everything is given, in all of its details, as the result of the author's own careful study and actual personal experience, and, he says, "I have simply narrated the work of my hands."

A Dictionary of Music and Musicians. Edited by George Grove, D. C. L. Parts XX and XXI. New York: Macmillan & Co. Pp. 256. Price, $1.

These numbers embrace the titles from "'Tis the Last Rose of Summer" to "The Water-Music." Among the longer articles are one on "Variations," "The Violin," "Violin-Playing," and ample biographical sketches, with accounts of their works, of Verdi, the Abbé Vogler, and Richard Wagner.

The Journal of Physiology. Edited by Michael Foster, with Co-operators in England and America. Vol. VI, Nos. 4 and 5. American Agency with Professor H. Newell Martin, Johns Hopkins University. Baltimore: Pp. 156, with Plates. Price, $5 a volume.

The "Journal of Physiology" is the recognized register of physiological research by English-speaking investigators, and presents as they are accumulated the results of the studies of those distinguished experimentists, on either side of the ocean, whose discoveries have been the means of contributing so much to the intelligent and efficient treatment of human affliction. The present number contains papers by G. F. Yeo and J. W. Barrett, S. Ringer, H. Sewall and D. W. Steiner, J. A. McWilliam and T. Wesley Mills, on various aspects of the heart; S. Ringer and D. W. Buxton, on contractile tissue, etc.; C. S. Sherrington on the spinal cord of the dog; E. F. Herroun and G. F. Yeo, on "The Sound accompanying the Single Contraction of Skeletal Muscle"; and transcripts from the Proceedings of the Physiological Society, 1885.

Revision of the Palæocrinoidea. Part III. First Section. By Charles Wachsmuth and Frank Springer. Philadelphia: William P. Kildare, Printer. Pp. 138, with Eight Plates.

Hardly any kinds of fossils are more attractive to the collector than the crinoids, with their endless variety of forms, each distinguished by its peculiar style of beauty and grace; and hardly any other kind offers a richer reward to the searcher for specimens who is so fortunate as to find a bed of them. Since the first part of this work was published, some five years ago, great progress has been made in the study of both the recent and fossil members of the order, and many new and interesting forms have been discovered and described. The authors of the monograph confess that their own knowledge of the subject also has grown. The present section of the work includes a discussion of the classification and relations of the Brachiate crinoids, with generic descriptions. A second section is promised in the "Proceedings of the Philadelphia Academy of Natural Sciences" for 1886, to contain the Articulata and Quadrinata.

The Published Writings of Isaac Lea, LL. D. By Newton Pratt Scudder. Washington: Government Printing-Office. Pp. 278.

This is Bulletin No. 23 of the United States National Museum, and is the second of a series of bibliographies of American naturalists which the Museum is publishing. Dr. Lea is our oldest conchologist, and is one of the most laborious and fruitful devotees in that branch of research that our country has had. He is still living, in his ninety-fourth year, and blessed with good health and unimpaired mental and physical faculties. The list of his publications, as given in this work, with full descriptions of each, includes 279 titles. His cabinet of *Unionidæ* in Philadelphia displays about ten thousand individuals, of different ages, so arranged that each may be separately examined, and it is unique in having many species arranged with a sequence from the youngest to the oldest, so that the student may see at a glance the aspect of their growth.

Bulletin of the Sedalia Natural History Society. Sedalia, Mo. No. 1, August, 1885. F. A. Sampson, Corresponding Secretary. Pp. 30.

The society was organized January 14, 1884, and has been able to report a year and a half of successful operation. This first number of its "Bulletin" contains its constitution and by-laws, list of officers, and acknowledgments of contributions; together with papers on the "Shells of Pettis County," by F. A. Sampson, and "Pettis County Pentremites," by Dr. G. Hambach.

Bulletin of the Minnesota Academy of Natural Sciences. Volume II. No. 5. C. W. Hall, Secretary, Minneapolis, Minn. Pp. 84.

The present number of the "Bulletin" includes papers from May, 1881, to December, 1882, the publication of which has before been unavoidably delayed. Among the more important papers are a report "On Some Tests of Building-Stones," by J. A. Dodge; a report on the "Mineralogy of the State, with Notes on the Bibliography of the Subject," by N. H. Winchell; and "Meteorological Statistics of Minneapolis for Eighteen Years," by William Cheney.

The System of High Licenses: How it can be made successful. By G. Thomann. New York: The United States Brewers' Association. Pp. 36.

The imprint of this publication indicates the point of view from which the subject is considered. The paper is a plea for discrimination in the imposition of licenses in favor of what are called the lighter drinks. The author cites, in support of his views, from the records of licensing and liquor-selling in Switzerland and various places in Germany.

An Iron Crown: A Tale of the Great Republic. Chicago: T. S. Denison, 1885. Pp. 560. Price, $1.50.

In the course of this story the attempt is made to show the dangers to free government threatened in the growing abuses of corporate power. It deals with millionaires, mining, railroads, etc., and takes the side of the people against the "daring freebooters who would seize the people's rights."

The Fixed Idea of Astronomical Theory. By August Tischner. Leipsic: Gustav Fock. Pp. 86.

We several months ago noticed the book by this author, "The Sun changes his Position in Space, therefore he can not be regarded as being in a Condition of Rest," in which the competency of the present astronomical system is attacked because it is based on the assumption of a fixed sun. In the present work the author postulates a new theory which takes the motion of the sun into account.

Free Cities in the Middle Ages. By L. R. Klemm. Hamilton, Ohio. Pp. 22.

This paper, which was read before a local literary and scientific society, is after the German of G. F. Kalb, and sketches one of the most remarkable and interesting phenomena of modern history—the development and life of those free communities which maintained a prosperous and independent existence amid the degradation and conflicts of mediæval times, holding their own against the military barons and princes who would have crushed them if they could, and whose part was most important in preserving civilization and giving life to industry and art.

Bulletins of the United States National Museum, No. 28. A Manual of American Land-shells. By W. G. Binney. Pp. 528. No. 29, Results of Ornithological Explorations in the Commander Islands and Kamchatka. By Leonhard Stejneger. Pp. 382, with Eight Plates.

The "Manual of American Land-shells" appears as an enlarged and revised edition of "The Land and Fresh-water Shells of North America, Part 1," which was published by the Smithsonian Institution in 1869. Subsequently described species are added. Fuller attention is given in separate chapters to the subjects of geographical distribution, organs of generation, jaw and lingual dentition, and classification. In description, the species are grouped geographically rather than systematically. The work was prepared with Mr. Thomas Bland, who died in August, 1885, as co-author. The monograph by Mr. Stejneger is the first attempt to present a complete list of the birds known to have been observed in Kamchatka. It is divided into three parts, consisting of a review of the species of birds collected or observed by the author in the Commander Islands and at Petropaulski, a synopsis of the birds reported to inhabit Kamchatka, and conclusions. The second part is given to make the account of the birds of Kamchatka as complete as possible.

Reception Day, No. 4. New York: E. L. Kellogg & Co. Pp. 156. Price, 25 cents.

This is a collection of fresh and original dialogues, recitations, declamations, and short pieces for practical use in public and private schools. The compiler has aimed to have the pieces short, easy to be comprehended, infused with life and spirit, fitted for average pupils in the schools, and free from double-meanings and all that can verge on impropriety or vulgarity.

Notes on the Opium-Habit. By Asa P. Meylert, M. D. Fourth edition. New York: G. P. Putnam's Sons. Pp. 49.

Some additional data relative to the treatment of the habit have been inserted in this edition; and the author gives the result of his investigations on the administration of cocaine hydrochlorate as a specific.

PUBLICATIONS RECEIVED.

The Monthly Index. Vol. I, No. 1. Bangor, Mo.: Q. P. Index. P. 1. 25 cents a year.

The Relations of Mind and Matter. By Charles Morris. Pp. 100.

Function: Its Evolution and Influence on Organization. By C. N. Pierce, D. D. S. Philadelphia. Pp. 11.

Chronological List of Scientific Books and Papers. Pp. 16. Address to the Department of Pharmacy, State University of Iowa. Pp. 8. By Gustavus Hinrichs. Iowa City, Iowa.

Journal of the Trenton Natural History Society, Trenton, N. J. Vol. I, No. 1. Pp. 22.

Bowlder Mosaics in Dakota. By Professor J. E. Todd. Pp. 4, with Plate.

Household Receipts. Boston: Joseph Burnett & Co. Pp. 68. 25 cents.

Report on Drainage of Mystic, Blackstone, and Charles River Valleys, Massachusetts. Boston: Wright & Potter Printing Company. Pp. 243, with Plates and Maps.

Monthly Catalogue. United States Government Publications. Nos. 9 and 10. Washington, D. C.: J. H. Hickey. Pp. 20 each. $2 a year.

The Bizarre Notes and Queries, January, 1886. Manchester, N. H.: S. C. & L. M. Gould. Pp. 28. $1 a year.

South Pass Jetties. Pp. 37, with Maps. Letters to the Mississippi River Commission. Pp. 14. By James B. Eads. New York.

Illinois State Board of Health, Annual Meeting, 1886. Report of Proceedings. Springfield, Ill. Pp. 66. Decisions under Medical Practice Laws. Pp. 44. Conspectus of Medical Education. Pp. 138.

Hallucinations in Inebriety, etc. Pp. 20. States of Delirium in Inebriety. Pp. 7. By T. D. Crothers. Hartford, Conn.

Oxygen: Its Place in Therapeutics. By S. S. Wallian. New York. Pp. 30.

The Truth-Seeker Annual. New York: Truth-Seeker Office. 1886. Pp. 106. 25 cents.

Georgia Department of Agriculture. Supplemental Report of 1885. Atlanta: J. P. Harrison & Co. Pp. 52.

Directors' Report, Harvard Astronomical Observatory. Pp 13. Early Experiments in Telegraphing Sound. Pp. 7. By Edward C. Pickering. Cambridge, Mass.

Transactions of the State Medical Society of Wisconsin. 1885 Dr. J. T. Reeve, Secretary. Appletons. Pp. 170.

Reports on Electric Signal and Registering Apparatus. Philadelphia: Franklin Institute. Pp. 96, with Plates.

Technical Instruction in Europe. By Charles O. Thompson. Washington: Government Printing-Office. Pp. 55.

The Western Society of Psychical Research. J. E. Woodhead, Secretary. Chicago. Pp. 8.

Hearing and Deafness. By F. G. Riley, M. D. New York. Pp. 16.

Lunar Irregularities due to the Action of Jupiter. Washington: Bureau of Navigation, Navy Department. Pp. 20.

Quarterly Report of the Bureau of Statistics to September 30, 1885. Washington: Government Printing-Office. Pp. 241.

Report of the Industrial Education Association, New York, 21 University Place. Pp. 31.

Guide to Buyers and Sellers of Real Estate. By George W. Van Sicklen. New York. Pp. 58.

Report of the Prison Association of New York on Convict Labor. W. M. F. Round, Secretary. Pp. 15.

The Tehuantepec Ship Railway. By Elmer L. Corthell. Pp. 80. Proceedings of a Public Meeting at St. Louis. Pp. 28.

An Infidel's Plea for Christianity. By C. M. Clark. Seward, Neb. Pp. 16.

Western North Carolina as a Health Resort. By Henry O. Marcy. Boston. Pp. 24.

Extracts from G. von Rath's Notes on the Bement Collection of Minerals. Pp. 11. Meteoric Iron from Jenny's Creek, West Virginia. Pp. 4. By George F. Kunz. New York.

The Louisiana Purchase. By Bishop C. F. Robertson. New York: G. P. Putnam's Sons. Pp. 42. 50 cents.

The Theories of Ore Deposits. Pp. 14. The Keweenaw Series, etc., of Michigan. Pp. 9. By M. E. Wadsworth,

Transactions of the New York Academy of Sciences. Vol. III. 1883–'84. Pp. 186. Vol. V, Nos. 1 and 2. Pp. 73. $3 a year, or 40 cents a number.

Journal of the Cincinnati Society of Natural History, January, 1886. D. L. James, Secretary. Pp. 64, with Plate.

Transactions of the Anthropological Society of Washington. Vol. III. Smithsonian Institution. Pp. 204.

Hampton Institute: Its Work for Two Races. Hampton, Va. Pp. 34.

Diccionario Tecnológico, English-Spanish, No. 15. New York: N. Ponce de Leon. Pp. 116. 50 cents.

Cephalopoda of the Cincinnati Group. By Professor Joseph F. James. Cincinnati. Pp. 20, with Plate.

Catholic Historical Researches. Edited by the Rev. A. A. Lambing. Wilkinsburg, Allegheny County, Pa. January, 1886. Pp. 40. $1 a year.

Manual Training-School, Washington University, St. Louis. 1885–'86. Pp. 45.

Revista di Artiglieria e Genio (Review of Artillery and Engineering), December, 1885. Rome. Pp. 246.

John Cabot's Landfall in 1497, and the Site of Norumbega. By E. N. Horsford. Cambridge: John Wilson & Son. Pp. 41.

Evolution and Religion. By Henry Ward Beecher. Part II. New York: Fords, Howard, & Hulbert. Pp. 440. $1.

The Spartan and Theban Supremacies. By Charles Sankey. Pp. 231. The Early Hanoverians. By Edward E. Morris. Pp. 235. New York: Charles Scribner's Sons. $1 each.

Introduction to the Study of Chemistry. By Ira Remsen. New York: Henry Holt & Co. Pp. 387. $1.40.

Class Interests. Their Relations to Each Other and to Government. By the author of "Conflict in Nature and Life." New York: D. Appleton & Co. Pp. 172.

The New Agriculture. By A. N. Cole. New York: The "American Angler." Pp 223. $2.

Mechanics and Faith. By Charles Talbot Porter. New York: G. P. Putnam's Sons. Pp. 295. $1.50.

Rationalism in Medical Treatment. By William Thornton. Pp 46.

Mineral Resources in the United States. Reports for 1883 and 1884. By Albert Williams, Jr. Washington: Government Printing-Office. Pp. 1016.

History of California. By Theodore H. Hittell. Vol. I. San Francisco: Occidental Publishing House. Pp. 799. $5.

Oceana, or, England and her Colonies. By James Anthony Froude. New York: Charles Scribner's Sons. Pp. 396. $2.50.

Mechanical Integrators. By Professor Henry S. H. Shaw. New York: D. Van Nostrand. Pp. 212. 50 cents.

Household Remedies. By Felix L. Oswald. New York: Fowler & Wells Company. Pp. 229.

My Ten Years' Imprisonment. By Silvio Pellico. New York: Cassell & Co. Pp. 200. 10 cents.

Before Tilsit. By Count Leon Tolstoi. New York: W. S. Gottsberger. Two Vols. Pp. 322 and 357. $1.75.

History of Alaska. By Hubert Howe Bancroft. (Works, Vol. XXXIII.) San Francisco: A. L. Bancroft & Co. Pp. 775.

Marlborough. By George Saintsbury. New York: D. Appleton & Co. Pp. 219. 75 cents.

A History of German Literature. By W. Scherer. Translated by Mrs. F. C. Conybeare. Edited by F. Max Müller. New York: Charles Scribner's Sons. Two Vols. Pp. 401 and 425. $3.50.

Easy Lessons in German. By Adolphe Dreyspring. New York: D. Appleton & Co. Pp. 103. 70 cents.

Problems in Philosophy. By John Bascom. New York: G. P. Putnam's Sons. Pp. 222.

Popular Government. By Sir Henry Sumner Maine. New York: Henry Holt & Co. Pp. 261. $2.75.

Delsarte System of Dramatic Expression. By Genevieve Stibbins. New York: Edgar S. Werner. Pp. 271. $2.

The Determination of Rock-forming Minerals. By Dr. Eugen Hussak. Translated by Erastus G. Smith. New York: John Wiley & Sons. Pp. 233. $3.

Elements of Psychology, with Special Applications to the Art of Teaching. By James Sully. New York: D. Appleton & Co. Part I. Pp. 130. 25 cents.

Outlines of Psychology. With Special Reference to the Theory of Education. By James Sully, M. A., Examiner in the University of Cambridge, etc. Reading Club edition. Abridged and edited, with Appendices, Suggestive Questions, and References to Pedagogical Works, by J. A. Reinhart, Principal of the Normal Training-School, Paterson, N. J. C. W. Bardeen: Syracuse, N. Y. Pp. 372. $1.50.

POPULAR MISCELLANY.

The Real Nature of "Prodigies."—Mr. C. F. Cox has published, in the "Journal" of the New York Microscopical Society, a most interesting paper on "The So-called Prodigies of Earlier Ages." He believes that the stories of wonderful phenomena and portents with which the old books abound have a certain interest and value to the student and philosopher of to-day, "because they furnish landmarks in the progress of observation, and give us clews to that credulous state of the human mind which seems to have necessarily preceded the foundation of inductive reasoning." Themere historian of scientific discovery will also find in them what he must believe to be truthful statements of facts, mingled with distorted and erroneous interpretations and many unintentional misstatements of what were thought to be facts; and he may employ himself with some profit in separating the true from the false. Mr. Cox cites from a variety of books, particularly from Wolffhart's illustrated "Chronicle," a large list of wonderful appearances, which he divides into thirteen classes, for each of which he finds a particular way of accounting with an approach to satisfactoriness. Thus, the sweating and weeping of images, altars, etc., may be regarded as exaggerated cases of the condensation of vapor upon them. The bleeding of stones, shields, etc., was most probably the growth of the red lichen upon them, though it may in some cases have been rust. Showers of earth, chalk, ashes, etc., hardly need accounting for; and rains of brimstone may have been clouds of pollen, spores, or other yellow vegetable products. Showers of oil were probably not showers at all, but marks of supposed showers in the shape of greasy spots on the earth or stones or plants, or iridescent films on water; the appearance is sometimes produced by the growth of gelatinous protophytes, like the nostocs. The flowing of oil in brooks, etc., is also accounted for, as it would always be now, as a case of iridescence. Stories of showers of milk may have originated in the appearance of white spots, generally caused by growths of fungus, on leaves. The flowing of milk from the earth, in streams, etc., might be in most cases the superstitious interpretation of so simple a fact as the mixture of calcareous earth with ordinary running water; or, under favorable conditions, some of the lower forms of life might multiply so enormously as to give a milky hue to considerable bodies of water, as they do constantly under our own observation in a smaller way. The spotting of bread, grain, leaves, stones, etc., with blood, is a phenomenon easily accounted for by a very slight knowledge of the various forms and habits of the red and orange-yellow fungi. The flowing of blood in the ocean, rivers, springs, etc., is to be accounted for in some instances by the presence, in unusual quantities, of red algæ. "Showers of blood" may be referred to similar algæ; or deposits referable to such showers may be produced, as was known to be the case at Aix-la-Chapelle in July, 1608, by butterfly-chrysalides undergoing transformation, when large drops of a blood-colored liquid exude from them. Red snow is known to be a protococcus. "Showers of flesh"—one occurred in Kentucky in

1875, and was so accounted for—may occur when buzzards, having gorged themselves with carrion, disgorge it as they fly in the air. "Thus easily"—in the Kentucky case it was the flesh of a horse, and the buzzards were seen—"was a modern prodigy disposed of; and quite as rationally, we now see, might we dispose of all ancient prodigies which were not mendacious fabrications, if only we could catechise witnesses and apply scientific methods to the examination of such facts as were found to remain."

Study out of School.—On the question of study out of school-hours, Mr. L. W. Parish, of the Iowa State Teachers' Association, maintains that education should look to the most natural, complete development of physical, mental, and moral qualities. Neither side should be preferred at the expense of another, but all three should be developed hand in hand. To secure the proportionate and therefore most effective training of the intellectual powers, little or nothing is required, during the first three or four years of school-life, which a skillful and faithful teacher can not accomplish without forcing book-work upon the children during the evening hours, or during the time that belongs of right to physical development, or the performance of home duties. But, that the work may be done thus, unfavorable circumstances must be removed, and both pupil and teacher must do their parts. The pupil must be regular and industrious, and the teacher must show herself mistress of the best methods of presenting topics of instruction. On account of some irregular and unwholesome influences operating upon schools, more out-of-school study than is necessary or good is demanded, but an intelligent co-working of teachers, parents, physicians, and the local press ought to cause a steady decrease of it, and an increase in systematic physical and moral training.

The Search for the Trans-Neptunian Planet.—Mr. David P. Todd, of the Lawrence Observatory, Amherst, Massachusetts, has published a memoir on his search for the trans-Neptunian planet. He uses the definite article—the—in speaking of this body, hypothetical though it still may be, because he regards the evidence of its existence as well-founded, while, during all the time he has been engaged in the search of it, nothing has weakened his conviction of its existence in about that part of the sky he has assigned to it. The independent researches in cometary perturbations by Professor Forbes have furthermore conducted him to a result identical with Mr. Todd's—a coincidence, it is suggested, not to be lightly set aside as pure accident. That five years have elapsed since this coincidence was remarked, and the planet is still unfound, does not make it evident that the existence of the planet is merely fanciful, for the particular spot in which its presence is suspected has received very little scrutiny with telescopes competent to such a search. The time has now come when, by the help of the developments and improvements that have been made in astronomical photography, the search can be profitably undertaken by any observer having the rare combination of time, enthusiasm, and the necessary appliances. In aid of any such search, Mr. Todd has published a record of his observations of the indicated region, with the twenty-six-inch refractor telescope of the Naval Observatory, accompanied by exact transcriptions of the "finder" diagrams, and of diagrams showing the relative positions of objects.

Distribution of Trees in Canada.—Mr. A. T. Drummond, in a paper read before the British Association last year, on "The Distribution of Canadian Forest-Trees," ascribes an important part to the existence of large bodies of water in the eastern part of the country, and of conditions under which a much milder climate is given, with a higher range of trees, on the western side of the continent. Then, in the United States and Canada the mountain-ranges are somewhat continuous, and have a northern and southern trend, affording an opportunity to the northern trees to extend southward on their flanks, and to the southern trees to range northward in the valleys; and this has given rise to a more extended distribution than could otherwise occur. Another important element in the distribution is the chain of the lakes, which forms a barrier to the free extension into Canada of the southern forms common in our "lake States." Nevertheless, the currents of the lakes have been the means of distributing seeds on the jutting headlands of the northern coast, where a few southern forms have been found. On the other hand, the cooling effect of such large bodies of water encourages the growth of northern species, and thus around the coasts of Lake Superior the flora includes a few semi-Arctic plants, though inland these all disappear, and the vegetation is of a more northern temperate type. Only a few trees have the faculty of making themselves at home over as wide an extent as some herbaceous plants; and these are those usually which have light or winged seeds. One reason for the different development of this faculty in trees and herbs is probably that the seeds of trees are of greater size and weight, and less easily carried away from their parent. A break in the westward extension of a considerable number of the forest-trees occurs beyond Lake Superior and Red River. This is ascribed to the greater dryness of the climate west of that lake, the effect of which is also seen in the alleged superior quality of the wood of the aspen and spruce trees. Too much moisture in the atmosphere has also its results in determining the range of trees. The same causes which prevent the range westward beyond Red River of many of the Eastern trees, also prevail in restricting the eastward range of the British Columbia trees beyond the influence of the Rocky Mountains.

Local Climates of Exposure.—Professor W. Mattieu Williams, in the "Gentleman's Magazine," quotes with approval Dr. Frankland's recommendation of elevated snow-covered districts as winter sanitariums, and adds some observations of his own. Pertinently to the subject of reflection from waters, Professor Williams notices the position of Torbay, so celebrated for its mild winter climate, as on the one part of the Devonshire coast that has the most direct exposure to the east. "It hugs the east winds that blow directly into it from the open sea, and has no protection whatever from them. Paignton is the most directly exposed and the warmest part of the bay; the next is Torquay, or rather the Paignton side of Torquay." The mildness of the Torquay climate is also promoted by favorable inclination to reflection of the early morning sun-heat of the slopes, and by the tempering to which the east winds are subjected before reaching the land. At Broadstairs "is a little sandy bay backed by cliffs and facing directly east. I have several times on a sunny day in winter-time walked along the sands from the Granville side of Ramsgate to Broadstairs, and have been much interested in observing the sudden change of climate experienced on turning the projecting cliff forming the south horn of the bay. Ladies sit on the sands there with needlework and novels in the month of December." The sea-reflection is in many cases powerfully supplemented by cliff-reflection. "When the aspect is due south, as at Hastings, it overrides it altogether. The peculiar climate of Hastings is, I think, entirely due to this, for here we have the anomaly of sea-cliffs that have been deserted by the sea, which has left sufficient fore-shore for houses to be built between it and the cliffs. In the winter these cliffs warm these houses by reflecting the southward mid-day sun; in the summer they roast them. Not only do cliffs reflect some of the sun's rays during the day, but they absorb the remainder and give it out after the sun has set. . . . Other local climatic influences may be noted; among them the effect of a stretch of dry sand above high-water mark and at the foot of cliffs."

The Quaternary Moose of New Jersey.—Professor W. B. Scott has described, before the Academy of Natural Sciences of Philadelphia, a very large extinct moose or elk, the almost complete fossil skeleton of which, now in the Museum of Princeton College, was discovered in a shell-marl deposit under a bog at Mount Hermon, New Jersey. With the exception of five caudal vertebræ, every important bone of the skeleton that is missing is represented by its fellow of the opposite side, so that it has been hardly possible to go astray in making the necessary restorations. The skeleton is of an adult but not old individual, and appears to belong to the same species with one described by Wistar, and called by Harlan *Cervus Americanus*, which, together with some metacarpals described by Leidy, is preserved in the

Academy of Natural Sciences in Philadelphia. This species can not, however, be included in any known genus, as these are at present defined, and for that reason Mr. Scott has proposed for it the name *Cervalces Americanus*. The most obvious peculiarity of the skeleton is the great length of the legs, which gives the animal a stilted appearance, while the thorax is shallow and the neck short. The shoulders are higher than the hips, as in the moose, and unlike those of the stag. The combined length of the head and neck shows that in the ordinary position of the legs the muzzle would not reach the ground by fourteen or fifteen inches. Measured in the same manner, the moose's muzzle reaches to within about ten inches from the ground, and that of *Megaceros* to eight or nine inches. This and some other features of the structure indicate that the habits of the animal, and to some degree its appearance, were those of the moose. Its short neck shows that it would have great difficulty in grazing, and so probably lived by browsing upon shrubs and trees. This was aided by a more or less prehensile upper lip, which the character of the nasal opening shows to have been more proboscis-like than in the deer, though far less so than in the moose. Morphologically, the fossil is of interest for the light which it seems to throw upon the question of the genus *Alces*, and its relations to the typical deer.

Many Drugs: Few Remedies.—In an address on "Many Drugs: Few Remedies," Dr. George K. Welch, of Keyport, New Jersey, draws a highly-colored picture of the helplessness of the average medical practice in the face of disease. The schools increase and the graduates swarm, "but how many great physicians can you name, and which are the diseases borne under the annual spring-flood of doctors; and yet, where is the young doctor who does not believe in the magic of drugs, and the old doctor, if he be a wise man, who does not look upon the most of them as mischievous, and the minority as deserving of restriction? The pathologist is skeptical of them all. With laborious zeal we study diseases. . . . We anatomize and compare, and the professor awes with learned length while he discourses of the ills he can not cure. . . . Do we, waiting behind the eye of Koch, know anything of tuberculosis, or believe that he does? Does not the ravage go on? And who has won eminence in curing yellow fever? Are men no longer in dread of cholera? And the exanthemata—does not the grewsome pendulum of disease sweep into and out of every neighborhood about once in five years? Who cures rheumatism, or typhoid fever, or chronic Bright's disease? And where is the stout heart that never failed before a patient burning and broiling in the horrible slow flame of pyæmia? And yet, who refrains from prescribing? The witches move one way about the caldron, and we go the other; they throw in the drugs that brew the poisons, and we throw in the counter-poisons. Stillé and Maisch's 'Dispensatory' has a list of one hundred and fifty remedies for rheumatism, a disease which is as likely to become chronic with treatment as without it. Everybody has a specific, from your grand-aunt with teas, fomentations, and flannel, to the last German doctor with forty grains of salycilic acid to the dose. . . . The trouble is, medical thought moves too much toward specifics." Improvement must come, partly by enforcing the responsibility of every physician to all, or by the establishment of a college of experimental medicine, with a system of registration for correcting errors of observation; or, in other words, by adopting for the study of disease the methods of the experimental physiologists.

Reform of Juries.—The causes of the decline of juries and the remedy for it are considered by Mr. Edwin Young, of the Albany bar, in a paper on "The Jury in Modern Corporate Life." The theory of the institution, that "twelve disinterested freeholders of the neighborhood, of average intelligence and virtue, are best qualified to determine issues of fact," ought, if carried out, to secure an ideal tribunal. It does not secure it, but something far different. The reason of the deterioration that has come over juries is easily found in the exemptions allowed by law, some of them really unnecessary and even improper when the true view of the case is taken, which furnish a loop-hole through which a considerable body of our best citizens escape from service; in the abuse of the power and discretion of the court in granting excuses on the ground of "business engagements," or other trivial pretexts; in the collusion of officers to keep names off the jury-lists; and in public apathy and unwillingness to serve. Hence jury-duty has to be performed largely by persons who are not worthy of it, and who are often regardless of the obligation of an oath. "To revive its usefulness," Mr. Young says, "the jury must be purged. As an institution handed down by our forefathers, it is amply sufficient for the purposes for which it was intended. It is only in its abuse that we suffer, and that abuse can only be remedied by a revival of public spirit, and the realization of the fact that private interests are best subserved by the devotion of a part of our time to public duties."

Colored Audition.—M. A. de Rochas has published some notes on "Colored Audition," a faculty which some persons are alleged to possess of perceiving sensations of color in connection with the hearing of particular sounds. To most of the persons who have reported to him on the subject, acute sounds and the vowel *i* (French) appear red or of a brilliant color, but the variations in the matter are infinite. One lady associates its especial color with each note of the musical scale, each vowel, and each digit; and she never hears any sum mentioned without the colors of all the figures it contains passing in succession before her eyes. Another lady sees names colored—John, bright red; Joseph, very dark blue; Louis, red; Louisa, blue; and Lucy, yellow; while all names ending in *us* are green. An engineer associates a color with the name of every day of the week. To him, Monday is a gray day; Tuesday and Wednesday, white; Thursday, yellow; Friday, Saturday, and Sunday, dark-red. Most of the persons known to have this faculty have had it from infancy.

The National Museum.—By a "Handbook" just published by Ernest Ingersoll and his associates, Messrs. Taylor and Ainsworth, the National Museum at the Smithsonian Institution, Washington, is shown to be a group of most interesting and varied collections. It started with the remarkable and heterogeneous accumulation of curiosities at the Patent-Office which once formed one of the great attractions for visitors to the national capital. The Smithsonian Institution having been organized and housed, and the Patent-Office having become too full of the models and goods legitimately its own, the curiosities were turned over to the care of the Smithsonian agents. To these collections have been added from time to time—after the Centennial Exhibition, the government exhibits of other countries; the zoölogical treasures of the Fish Commission; specimens of natural resources from Territorial surveys; the mineralogical, geological, archæological, anthropological, and natural history treasures that have been gathered in the course of the Government surveys which have been systematically carried on over our whole domain; and various articles, special collections, etc., gathered from different quarters of the globe. The museum is housed in dust-proof plate-glass cases, in a building which has been constructed expressly for it, and which is described as having been filled up from the Greek cross radiating from a central rotunda into a complete square, the exterior walls of which are three hundred and seventy-five feet in length. The various collections have been scientifically and topically classified and arranged, and are accessible in the several departments of geology, mineralogy, chemistry, economic geology, and metallurgy, as representing the inorganic world; and of botany, zoölogy, anthropology, archæology, ethnology, and comparative technology, as representing the organic world; each of the departments being further subdivided according to its various branches. The museum is under the care of Dr. Spencer F. Baird as director, and G. Brown Goode as assistant director, with twenty-four curators, all but nine of whom serve without expense to it.

Poetry and Reality in Zuñi.—Dr. R. W. Shufeldt, U. S. Army, in a sketch, in "Forest and Stream," of an excursion through Zuñi-land, speaks of his entrance into the pueblo as like stepping from the pictures—which we have in the descriptions of Mr. Cushing and others—into the reality. "There were the squarish houses all piled up on one another, and the chimney-pots and openings on the roof; there bristled up in many directions the tops of the ladders; there were the Zuñis themselves on the roofs with others in the streets, bearing on their heads the very jars, the like of which I had so often seen my artist friends in the National Museum illustrating; in short, here was Zuñi, for it has not its counterpart in all the world. At our approach a dozen dogs raised the alarm, and off scampered a group of half-naked children of both sexes with their black, negro-like heads of hair (the biggest part of some of them) blowing in the wind. Strange as it may seem, our first inquiry was, how came the hill there upon which this ancient pueblo was erected? The plain for miles about it is almost as level as the surface of a lake. Imagine the impression it made upon us when, after our examination, the undeniable fact stared us in the face that although Zuñi may have originally been started on a slight rise in the plain, yet its present elevation—between thirty and forty feet above the datum plane—is due largely in some places to the accumulated excrement of the burros, and I suspect, too, to some degree, the refuse from the houses! This condition can better be seen at the pueblo of Las Nutrias, where the entire lower stories of some of their houses are covered above their roofs by a like guano deposit, while additional stories have been built on and above them. In Zuñi this condition is more particularly the case on the side of the pueblo facing toward the missionary-house. In this situation the side of the hill has been cut away to make room for a garden, and its composition is easily studied. I am not aware that this fact has been published before; but it seems hardly possible that a thing so evident has been overlooked. We were disappointed at finding the pueblo so nearly deserted. Not more than one house in ten was occupied, as every able-bodied man and woman was at this time of the year away planting wheat, as we saw them at Las Nutrias. Upon leaving home, a Zuñi closes the little low door to his house by piling a quantity of stones up in front of it. He also takes the precaution to plaster up with clay the opening upon the roof. Such fastening is considered a sacred seal, and no honest one would think of breaking it any more than we would a seal to a letter. We saw all the empty houses closed up in this way, and it lent the pueblo a terribly deserted appearance." All of the poetry of the scene was taken out by the remark of one of Dr. Shufeldt's companions, an eminent professor, as they turned to go away, that "he had seen enough of that mass of hovels on a dung-hill, inhabited by people whose habits and customs are too frightful to think of." In fact, every law known to sanitary science seemed to be violated at the pueblo.

The Fine Arts in Burmah.—Several of the fine arts flourish to a certain degree in Burmah, although none of them are as highly developed as they are in India. Weaving is very ancient and is widely diffused throughout the country, yet the weavers of the finest and most highly adorned fabrics are foreigners, the descendants of slaves brought from Manipur. In drawing, Burmans who are trained to any art are masters of the pencil, although they have little idea of perspective or of the balance of light and shade. While the details are conventional, the general idea is the creation of the workman, and the pictures are often full of life and humor. Decoration of funeral-pyres with paintings, sometimes extremely grotesque, is an important branch of this art. Brass-founders make images of Gotama, bells of various characters, and the flat, crescent-shaped gongs which are used for religious purposes. Wood-carving has a very extensive range of variety in character. Some of the work in foliage and figures in the Buddhist monasteries is remarkably beautiful, as well in the delicacy of the curves as in the lightness and grace of the open tracery. An Institute of Industrial Arts has been established at Rangoon, to develop this industry. A curious and intricate effect is obtained in carving some articles in ivory, when "the outside of the specimen is carved with foliage and flowers, through the interstices of which the inside is hollowed out nearly to the center, where a figure is carved *in situ*. The figure looks as if it had been carved separately and inserted into a flowery bower, but closer examination shows that this is not the case, and the men may be at any time seen carving the figure through the opening of the tracery." Every village larger than a hamlet has its goldsmith and silversmith. In the filigree ornaments made by goldsmiths, the burnished gold retains its proper color, but the other gold is dyed red with tamarind-juice, a barbaric custom to which the Burmese cling tenaciously. The reason given for it is that no other metal but gold will assume this particular ruddy color when treated with tamarind-juice; it may in fact be regarded as the hall-mark of Burmese jewelry. The silver-work of Burmah is much esteemed by connoisseurs all over the world; the artists treat this metal so as to obtain the greatest possible effect that the nature of the material allows. The trade is not a paying one, but the leading artists are devoted to their art, and are quite content if they gain enough to live on, provided that they keep their position at the head of the craft. Many of them are proficient in niello-work, in which the design appears as if drawn in silver outline on a black ground.

An Earthquake Experience.—A French gentleman residing at Mendoza, in the Argentine Republic, gives a graphic description in "La Nature" of the earthquake that took place there on the 30th of March, 1885, at about half-past ten in the evening. He was reading and smoking, when one of the sashes of his window opened all at once and immediately closed again with noise. He thought a dog had come in through the window, and bent over to look for the intruder under his desk. The window opened again, and he was obliged to hold on to his desk, while his chair leaned over with him. He straightened himself again, and was thrown to the right. At the same time his jaws came together and he bit off his pipe-stem, while he felt a pain in the pit of his stomach, like that of sea-sickness. Then the thought occurred to him that it was an earthquake. Six seconds afterward he heard a noise like that of a distant locomotive letting off steam, followed by the howling of dogs and the noise of the wind through the plantain-trees. Then he saw the angle of the wall veer slowly to the left, then return to its place, so speedily that he was scared and ran to the door to get out. The door would not open. The dogs kept on howling louder than ever. He burst the door open, and, running out, found all the people in the streets, mostly in their night-dresses. Three violent shocks were felt. The writer of the account believes that a fourth shock would have destroyed the town. The sky was afterward obscured with fog; and, for thirty seconds after the last shock, a subterranean noise was heard like the rumbling of a railroad-train in the distance.

NOTES.

Sir W. Temple, in his "Essays of Health and Long Life," recommends, as the strongest preservative against contagions, a piece of myrrh held in the mouth. It has been asserted that Eastern physicians invariably adopt this protection when attending the sick.

A memorial window to the late Sir William Siemens, erected by his brother engineers, was unveiled in Westminster Abbey, November 26, 1885, with addresses by the Dean and Sir F. Bramwell.

The article by Professor Rood, entitled "The Problem of Photography in Color," published in the last "Monthly," and credited to the "Photographic Bulletin," should have been credited to "Anthony's Photographic Bulletin."

M. Pagès, in the course of his experiments in photographing the movements of horses, has been struck by the observation that the foot of the animal, being half the time at rest on the ground, must, during the other half the time, be in much more rapid motion than the animal itself. He estimates that in the gallop the foot reaches a velocity of sixty metres, or about two hundred feet, a second.

Dr. C. V. Riley, Entomologist of the Department of Agriculture, and Honorary Curator of Insects in the National Museum, has given to that institution his extensive private collection of North American insects, representing the fruits of his labors in collecting and study for many years.

The Mexican Government is said to be contemplating the establishment of a meteorological station among the highest mountains of the country, at an elevation of nearly twenty thousand feet above the level of the sea. Instruments for its use, as far as possible to go a year without stopping, are being made at Zürich, Switzerland.

"Naturen," of Christiania, Norway, calls attention to notices that have been given of Scandinavian observations in the past, of phenomena parallel with the "after-glows" of 1883-'84. A series of these glows, observed in 1636, was ascribed at the time to the eruption of Hecla, which occurred in that year. From May to September, 1783, the heavens were illuminated by a constant red glow, and the sun had the appearance of a faint disk. This was attributed to a violent eruption of the Skaptar Jökul, Iceland, which occurred in the spring of the same year.

A correspondent of "Nature," who has tried various schemes of automatic ventilation and found them all to fail at times, though usually working well, announces his conclusion that there is no rule in the matter without exception. This means that ventilation should receive personal attention, and be always under observation.

OBITUARY NOTES.

Dr. Thomas Andrews, an Irish chemist, died about the 1st of December, 1885, in the seventy-second year of his age. He was born in Belfast in 1813. In preparing himself for the medical profession he studied chemistry under several eminent masters. He took a part, as vice-president, in the organization of the Northern College, now Queen's College, Belfast, and was its first Professor of Chemistry. His name is identified with many most important investigations and discoveries. Among them are the composition of the blood of cholera-patients; the determination of heat evolved during chemical action; the true nature of ozone, in which he established the theory now universally held; and the continuity of the liquid and gaseous states of matter, a series of investigations which led directly up to Pictet's, Cailletet's, Wroblewski's, and others', successful liquefaction of all the gases.

Xavier Ullesberger, a Swiss paleontologist, died recently at Ueberlingen, on the Lake of Constance, seventy-nine years old. He was the discoverer of the lake villages at Nussdorf, Maurach, Uhldingen, and Sipplingen; and he obtained a large collection of prehistoric objects, which is preserved at Stuttgart.

The death is announced, at the age of eighty years, of Professor Giuseppe Ponzi, the Italian geologist.

Professor Charles E. Hamlin, of the Agassiz Museum of Natural History, died at Cambridge on the 3d of January. He was about sixty years old.

Alfred Tribe, an English chemist, died November 26, 1885, aged forty-six years. He acquired his first knowledge of chemistry when, as a boy, waiting on the students at the Royal College, he repeated some of the experiments he saw performed, in the kitchen at home. He was assistant to Dr. J. H. Gladstone for twenty years, and head of his laboratory. He was Demonstrator of Chemistry at St. Thomas's Hospital, Lecturer on Metallurgy at the National Dental Hospital, and Lecturer on Chemistry and Director of Practical Chemistry in Dulwich College. He was an assiduous investigator, and published a large number of papers, some under his own name, and others in conjunction with Dr. Gladstone.

Mr. Edwin Ormond Brown, Assistant Chemist to the British War Department, died December 12th. He had been connected with the arsenal at Woolwich for about thirty years, and had been instrumental in the improvement of gun-cotton and other explosives.

Daniel David Beth, the chief of the Dutch African Expedition, died at Katumbella, on the 19th of May, 1885. He took part in an expedition to the interior of Sumatra, 1877 to 1879, where he became interested in the examination and prospective development of the coal-fields of the island. In 1882 he busied himself to secure a proper representation of the colonial products at the Amsterdam Exposition. In 1884 he started on his African expedition, which had especial reference to the Kunene River, and the mountain-range lying north and west of it.

Dr. Samuel Birch, the chief of British Egyptologists, and founder and President of the Society of Biblical Archæology, died December 27th. He was born in 1813, and was appointed to the Department of Antiquities in the British Museum in 1836. He was at first specially interested in Chinese antiquities, but, without giving up his tastes in that direction, became pre-eminently an Egyptologist. Besides preparing numerous works and papers of his own, he contributed a translation of the "Book of the Dead," a dictionary of hieroglyphics, and a grammar to Bunsen's great work on Egypt. He was also connected, officially and personally, with the publication of "Records of the Past," twelve volumes of translations of the more important texts from the Egyptian and Assyrian monuments.

M. Louis René Tulasne, a French mycologist, whose fame would have been greater had he been less modest and enjoyed better health, died at Hyères on the 22d of December, 1885. He became a member of the French Academy in 1854, but was forced by his delicate constitution to retire from active life in 1864. During the twenty-five years to which his work was limited, he made many important investigations in the fungi and the lichens, the science of which, it is said, he reformed as well as augmented.

CHRISTIAN HUYGENS.

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AN ECONOMIC STUDY OF MEXICO.

By DAVID A. WELLS.

I.

IT is proposed to here ask attention to the results of a recent investigation and study of Mexico, with the intent of exhibiting its economic relations to the United States, and of helping to determine the desirability of the ratification on the part of the latter of a Mexico-American commercial treaty. The basis for this investigation and for such opinions as may be expressed has been: First, a somewhat extended exploration of Mexico, undertaken during the early months of the past year (1885), primarily with a view to health and recreation; and, secondly, a subsequent careful study (prompted by interest in what had been personally seen or heard) of the physical situation and history of the country, and its present political, industrial, and social condition. The journey, it may be further premised, was mainly made upon a special train, over the whole length of the Mexican Central Railroad, over most of the Vera Cruz and City of Mexico and over a part of the Mexican National Railroads; the aggregate distance traversed within the territory of the republic being in excess of three thousand miles, the train running upon its own time, with its own equipment for eating and sleeping, and stopping long enough at every point of interest—city, town, *hacienda*, mine, or desert—to admit of its full and satisfactory exploration. It is safe, therefore, to say that such an opportunity for leisurely visiting and studying so much of Mexico had rarely, if ever, before been granted.*

* The excursion in question was made under the auspices of the Raymond Excursion Company, and was the first of its kind projected and carried out by it.

Although geographically near, and having been in commercial relations with the rest of the world for over three hundred and fifty years, there is probably less known to-day about Mexico than of almost any other country claiming to be civilized; certainly not as much as concerning Egypt, Palestine, or the leading states of British India; and not any more than concerning the outlying provinces of Turkey, the states of Northern Africa, or the seaport districts of China and Japan. It is doubtful, furthermore, if as large a proportion as one in a thousand of the fairly educated men of the United States or of Europe could at once, and without reference to an encyclopædia, locate and name the twenty-seven States or political divisions into which the Republic of Mexico is divided, or so many of its towns and cities as have a population in excess of fifteen or twenty thousand. The explanation of this is that, prior to the construction and opening of the Mexican "Central" and Mexican "National" Railroads, or virtually prior to the year 1883, the exploration of Mexico—owing to the almost total absence of roads and of comfortable *hospicia* for man and beast, the utter insecurity for life and property, the intervention of vast sterile and waterless tracts, and the inhospitality and almost savagery of no small proportion of its people—was so difficult and dangerous that exploration has rarely been attempted; and those who have attempted it have greatly imperiled their lives, to say nothing of their health and property. Mexico, furthermore, is not fully known even to the Mexicans themselves. Thus, a large part of the country on the Pacific coast has scarcely been penetrated outside of the roads or "trails" which lead from the seaports to the interior. There are hundreds of square miles in Southern Mexico, especially in the States of Michoacan and Guerrero, and also in Sonora, that have never been explored; and whole tribes of Indians that have never been brought in contact with the white man, and repel all attempts at visitation or government supervision. During the three hundred years, also, when Mexico was under Spanish dominion, almost access to the country was denied to foreigners; the most noted exception being the case of Humboldt, who, through the personal favor and friendship of Don Marino Urquijo, first Spanish Secretary of State under Charles IV, received privileges never before granted to any traveler; and thus it is that, although more than three quarters of a century have elapsed since Humboldt made his journey and explorations, he is still quoted as the best and, in many particulars, as the only, reliable authority in respect to Mexico.

In 1850, Bayard Taylor, returning from California, visited Mexico, landing at Mazatlan, and crossing the country by way of the city of Mexico to Vera Cruz. His journey lasted from the 5th of January to the 19th of February—a period of about six weeks—and the distance traversed by him in a straight line could not have been much in excess of seven hundred miles—a rather small foundation in the way of exploration for the construction of a standard work of travel; yet, whoever reads his narrative and enters into sympathy with the author (as who in reading Bayard Taylor does not?) is heartily glad that it is no longer—for Mungo Park in attempting to explore the Niger, or Bruce in seeking for the sources of the Nile, or Livingstone on the Zambesi, never encountered greater perils or chronicled more disagreeable experiences of travel. It was not enough to have "journeyed," as he expresses it, "for leagues in the burning sun, over scorched hills, without water or refreshing verdure, suffering greatly from thirst, until I found a little muddy water at the bottom of a hole"; to have lived on *frijoles* and *tortillas* (the latter so compounded with red pepper that, it is said, neither vultures nor wolves will ever touch a dead Mexican), and to have found an adequate supply of even these at times very difficult to obtain; to sleep without shelter or upon the dirt floors of *adobe* huts, or upon scaffolds of poles, and to have even such scant luxuries impaired by the invasions of hogs, menace of ferocious dogs, and by other enemies "without and within," in the shape of swarms of fleas, mosquitoes, and other vermin; but, in addition to all this, he was robbed, and left bound and helpless in a lonely valley, if not with the expectation, at least with a feeling of complete indifference, on the part of his ruffianly assailants, as to whether he perished by hunger and cold, or effected a chance deliverance. And if any one were to travel to-day over the same route that Bayard Taylor followed, and under the same circumstances of personal exposure, he would undoubtedly be subject to a like experience.

In August, 1878, Hon. John W. Foster, then United States minister to Mexico, writing from the city of Mexico to the Manufacturers' Association of the Northwest, at Chicago, made the following statement concerning the social condition of the country at that time: "Not a single passenger-train leaves this city (Mexico) or Vera Cruz, the (then) termini of the only completed railroad in the country, without being escorted by a company of soldiers to protect it from assault and robbery. The manufacturers of this city, who own factories in the valley within sight of it, in sending out money to pay the weekly wages of their operatives, always accompany it with an armed guard; and it has repeatedly occurred, during the past twelve months (1878), that the street railway-cars from this city to the suburban villages have been seized by bands of robbers and the money of the manufacturers stolen. Every mining company which sends its metal to this city to be coined or shipped abroad always accompanies it by a strong guard of picked men; and the planters and others who send money or valuables out of the city do likewise. The principal highways over which the diligence lines pass are constantly patroled by the armed rural guard or the Federal troops; and yet highway robbery is so common that it is rarely even noticed in the newspapers. One of the commercial indications of the insecurity of communication between this capital and the other cities of the republic is found in the rate of interior exchange," which at that time, according to the minister, varied from ten per cent in the case of Chihuahua, distant a thousand miles, to two and two and a half per cent for places like Toluca, not farther removed than a hundred miles. Matters are, however, in a much better state at present, and for reasons that will be mentioned hereafter; but the following item of Mexican news, telegraphed from Saltillo (Northern Mexico), under date of February 15, 1885, pretty clearly indicates the scope and desirability for future improvement, and also the present limitation on the authority of the existing national Government: "The commission of officers sent from Zacatecas by the Government to treat for a surrender with the noted bandit leader, Eraclie Bernal, has returned, having been unsuccessful in its mission. The chief demanded the following conditions: Pardon for himself and band, a bonus of thirty thousand dollars for himself, to be allowed to retain an armed escort of twenty-five men, or to be appointed to a position in the army commanding a district in Sinaloa."

How such a statement as the foregoing carries the reader back to the days of the "Robbers of the Rhine," or the "free lances" of the middle ages! With a better government and increased railroad facilities, the amount of travel in Mexico has of late years greatly increased. Before the opening of the Mexican Central, in 1883, the majority of travelers entered the country at the port of Vera Cruz, and journeyed by railroad (opened in 1873) to the capital (two hundred and sixty-three miles), and returned without stopping *en route* in either case; or else made excursions of no great distance from points on our southern frontier into the northern tier of Mexican States—Sonora, Chihuahua, Coahuila, and Tamaulipas—such journeys being usually made on horseback, with preparations for camping out, and also for fighting if it became necessary. Since the opening of the Mexican Central, however, this route offers the greatest facilities for those who desire to reach the city of Mexico, the traveler journeying by a fast train, day and night, the whole route (twelve hundred and twenty-five miles) from El Paso, in the very best of Pullman cars, over a good road, with every accommodation save that of food, which, in spite of the efforts of the company, is and will continue to be bad, simply because the country furnishes few resources—milk selling at some points as high as twenty-five cents a quart and scarce at that, while butter as a product of the country is almost unknown. But, enter Mexico by whatever route, the ordinary traveler has little opportunity to see anything of the country apart from the city of Mexico, save what is afforded by the view from the car-windows, and yet it is from just such experiences that most of the recent books and letters about Mexico have been written.

There is a wonderful depth of truth in a remark attributed to Emerson, that "the eye sees only what it brings to itself the power to see"; and the majority of those who in recent years have visited Mexico would seem to have brought to their eyes the power of seeing little else than the picturesque side of things. And of such material there is no lack. In the first place, the country throughout is far more foreign to an American than any country of Europe, except that part of Europe in close proximity to its Asiatic border. Transport a person of tolerably good geographical information, without giving him any intimation as to where he was going, to almost any part of the great plateau of Mexico—outside of the larger cities—and he would at once conclude that he was either at Timbuctoo or some part of the "Holy Land." The majority of the houses are of *adobe* (mud), destitute of all coloration, unless dust-gray is a color, and one story in height. In Palestine, however, and also (according to report) in Timbuctoo, the roofs are "domed"; in Mexico they are flat. The soil is dry, the herbage, when there is any, coarse and somber, and the whole country singularly lacking in trees and verdure. In the fields of the better portions of the country, men may be seen plowing with a crooked stick, and raising water from wells or ditches into irrigating trenches, by exactly the same methods that are in use to-day as they were five thousand years ago or more upon the banks of the Nile. In the villages, women with nut-brown skins, black hair, and large black eyes, walk round in multitudinous folds of cotton fabrics, often colored, the face partially concealed, and gracefully bearing water-jars upon their shoulders—the old familiar Bible picture of our childhood over again, of Rebecca returning from the fountain.

Place a range of irregular, sharp, saw-tooth hills or mountains, upon whose sides neither grass nor shrub has apparently ever grown, in the distance; a cloudless sky and a blazing sun overhead; and in the foreground a few olive-trees, long lines of repellent cacti defining whatever of demarkation may be needed for fields or roadway, and a few donkeys, the type of all that is humble and forlorn—and the picture of village life upon the "plateau" of Mexico is complete.

Would any one recall the "Flight of the Holy Family into Egypt," it is not necessary to visit the galleries of Europe and study the works of the old masters, for here on the dusty plains of Mexico all the scenes and incidents of it are daily repeated: Mary upon a donkey, her head gracefully hooded with a blue *rebozo*, and carrying a young child enveloped on her bosom in her mantle; while Joseph, the husband, bearded and sun-sorched, with naked arms and legs, and sandals on his feet, walks ploddingly by her side, with one hand on the bridle, and, if the other does not grasp a staff, it is because of the scarcity of wood out of which to make one, or because the dull beast stands in constant need of the stimulus of a thong of twisted leather.

Madame Calderon de la Barca, the Scotch wife of one of the first Spanish ministers sent to Mexico after the achievement of her independence, and who wrote a very popular book on her travels in Mexico, published in 1843, also notes and thus graphically describes this predominance of the "picturesque" in Mexico:

"One circumstance," she says, "must be observed by all who travel in Mexican territory. There is not one human being or passing object to be seen that is not in itself a picture, or which would not form a good subject for the pencil. The Indian women, with their plaited hair, and little children slung on their backs, their large straw hats, and petticoats of two colors; the long string of *arrieros* with their loaded mules, and swarthy, wild-looking faces; the chance horseman who passes with his *serape* of many colors, his high, ornamental saddle, Mexican hat, silver stirrups, and leather boots—all is picturesque. Salvator Rosa and Hogarth might have traveled here to advantage hand-in-hand; Salvator for the sublime, and Hogarth taking him up where the sublime became ridiculous."

Where Indian blood greatly predominates in the women, the head, neck, shoulders, and legs, to the knee, are generally bare, and their garments little else than a loose-fitting white cotton tunic, and a petticoat of the same material, often of two colors.

At Aguas Calientes, within a hundred yards of the station of the Mexican Central Railroad, men, women, and children, entirely naked, may be seen bathing, in large numbers, at all hours of the day, in a ditch conveying a few feet of tepid water, which flows, with a gentle current, from certain contiguous and remarkably warm springs.

Shoes in Mexico are a foreign innovation, and properly form no part of the national costume. The great majority of the people do not wear shoes at all, and probably never will; but in their place use sandals, composed of a sole of leather, raw-hide, or platted fibers of the maguey-plant, fastened to the foot with strings of the same material, as the only protection for the foot needed in their warm, dry climate. And these sandals are so easily made and repaired, that every Mexican peasant, no matter what may be his other occupation, is always his own shoemaker. As a general rule, also, the infantry regiments of Mexico wear sandals in preference to shoes. Very curiously, the pegged shoes of the United States and other countries are not made and can not be sold in Mexico, as, owing to the extreme dryness of the atmosphere, the wood shrinks to such a degree that the pegs speedily become loose and fall out.

In the country, the so-called *peons*, or agricultural laborers, who comprise nearly all the population, are, as a matter of fact, permanently attached to the soil of the great estates, through conditions respecting the obligation of debts that practically amount to slavery; and it is claimed that the keeping of the peons constantly in debt—a matter not difficult to accomplish by reason of their ignorance and improvidence—and so making permanent residence and the performance of labor obligatory on them—is indispensable for the regular prosecution of agriculture; inasmuch as the peon, if free, can never be depended upon, if he gets a few dollars or shillings in his pocket, and there is a place for him to gamble within from fifty to one hundred miles' distance. It is to be noted, however, that, wherever Mexico comes in contact with the outside world, the peon system tends to decay; and in the northern States of Mexico, where American ideas are finding their way among the people, and the construction of railways has increased the opportunities for employment, and raised wages, it is already practically abandoned. On each estate, or *hacienda*, there are buildings, or collections of buildings, typical of the country, borrowed originally, so far as the idea was concerned, in part undoubtedly from Old Spain, and in part prompted by the necessities for defense from attack under which the country has been occupied and settled, which are also called *haciendas*, the term being apparently used indifferently to designate both a large landed estate, as well as the buildings, which, like the old feudal castles, represent the ownership and the center of operations on the estate. They are usually huge rectangular structures—walls or buildings—of stone or adobe, intended often to serve the purpose, if needs be, of actual fortresses, and completely inclosing an inner square, or court-yard, the entrance to which is through one or more massive gates, which, when closed at night, are rarely opened until morning. Within the court, upon one side, built up against an exterior wall, is usually a series of adobe structures—low, windowless, single apartments—where the peons and their families, with their dogs and pigs, live; while upon the other sides are larger structures for the use or residence of the owner and his family, or the superintendent of the estate; with generally also a chapel and accommodations for the priest, places for the storage of produce, and the keeping of animals; and one or more apartments entirely destitute of furniture or of any means of lighting or ventilation, save through the entrance or doorway from the court-yard, which are devoted to the reception of such travelers as may demand and receive hospitality to the extent of shelter from the night, or protection from outside marauders. Such places hardly deserve the name of inns, but either these poor accommodations or camping out is the traveler's only alternative. They put one in mind of the caravansaries of the East, or better of the inns or *posadas* of Spain, which Don Quixote and his attendant Sancho Panza frequented, with the court-yard then, as now, all ready for tossing Sancho in a blanket in presence of the whole population. In some cases the *hacienda* is an irregular pile of adobe buildings without symmetry, order, or convenience; and in others, where the estate is large and the laborers numerous (as is often the case), only the most important buildings are inclosed within the wall—the peons, whose poverty is generally a sufficient safeguard against robbery, living outside and constituting a scattered village community. The owners of the large Mexican estates rarely live upon them, but make their homes in the city of Mexico or in Europe, and intrust the management of their property to a superintendent, who, like the owner, considers himself a gentleman, and whose chief business is to keep the peons in debt, or, what is substantially the same thing, in slavery. Whatever work is done is performed by the peons—in whose veins Indian blood predominates—in their own way and in their own time. They have but few tools, and, except possibly some contrivances for raising water, nothing worthy the name of machinery. Without being bred to any mechanical profession, the peons make and repair nearly every implement or tool that is used upon the estate, and this too without the use of a forge or of iron, not even of bolts and nails. The explanation of such an apparently marvelous result is to be found in a single word, or rather material, raw-hide, with which the peon feels himself qualified to meet almost any constructive emergency, from the framing of a house to the making of a loom, the mending of a gun, or the repair of a broken leg; and yet even under these circumstances the great Mexican estates, owing to their exemption from taxation, and the cheapness of labor, are said to be profitable, and, in cases where a fair supply of water is obtainable, to even return large incomes to their absentee owners.

In no truly Mexican house of high or low degree, from the adobe hut of the peasant to the stone palace erected by the Emperor Iturbide, are there any arrangements for warming or, in the American sense, for cooking; and in the entire city of Mexico, with an estimated population of from 225,000 to 500,000, chimneys, fireplaces, and stoves are so rare that it is commonly said that there are none. This latter statement is, however, not strictly correct; yet it approximates so closely to the truth that, but for provision for warm baths, there is probably no exception to it in any of the larger hotels of the city where foreigners most do congregate. Apart from the capital and some of the larger cities, Mexico is noticeably deficient in hotels or inns for the accommodation of travelers, and in a majority of the smaller towns there are no such places. And why should there be? The natives rarely go anywhere, and consequently do not expect anybody to come to them.

Large, costly, and often elegant stone edifices—public and private—are not wanting in the principal towns and cities of Mexico; but all, save those of very recent construction, have the characteristic Saracenic or Moorish architecture of Southern Spain—namely, a rectangular structure with rooms opening on to interior piazzas, and a more or less spacious court-yard, which is often fancifully paved and ornamented with fountains and shrubbery; while the exterior, with its gate-furnished archways and narrow and iron-grated windows, suggests the idea of a desire for jealous seclusion on the part of the inmates, or fear of possible outside attack and disturbance. Wooden buildings are almost unknown in Mexico, and in all interiors wood is rarely used where stone, tiles, and iron are possible applications. Consequently, and, in view of the scarcity of water, most fortunately, there are few fires in Mexico ; no fire departments, and but little opportunity for insurance companies or the business of insurance agents. As a general rule, the buildings of Mexico, exclusive of the huts, in which the masses of the people live, are not over one story in height, flat-roofed, and have neither cellars nor garrets ; and in buildings of more than one story the upper floor is always preferred as a dwelling, and thus in the cities commands the highest rents. There do not, moreover, seem to be any aristocratic streets or quarters in the cities of Mexico ; but rich and poor distribute themselves indiscriminately, and not unfrequently live under the same roof.

The popular opinion concerning Mexico is that it is a country of marvelous and unbounded natural resources. Every geography invites attention to the admirable location of its territory, between and in close proximity to the two great oceans ; to the great variety, abundance, and richness of its tropical products—sugar, coffee, tobacco, dye and ornamental woods, vanilla, indigo, cacao, cochineal, fruits, fibers, and the like ; and to the number of its mines, which for more than two centuries have furnished the world with its chief supply of silver, and are still productive. The result is, that with a majority of well-informed people, and more especially with those who have read about Mexico in those charming romances of Prescott, and who, in flying visits to its capital, have found so much to interest them in the way of the picturesque, and have brought to their eyes little capacity for seeing anything else, the tendency has been to confound the possible with the actual, and to encourage the idea that Mexico is a rich prize, unappreciated by its present possessors, and only waiting for the enterprising and audacious Yankees to possess and make much of, by simply coming down and appropriating.

Now, with these current beliefs and impressions the writer has little sympathy ; but, on the contrary, his study and observations lead him to the conclusion that the Mexico of to-day, through conjoined natural and artificial (or human) influences, is one of the very poorest and most wretched of all countries ; and, while undoubtedly capable of very great improvement over her present condition, is not speedily or even ultimately likely, under any circumstances, to develop into a great (in the sense of highly civilized), rich, and powerful nation. And in warrant and vindication of opinions so antagonistic to popular sentiment, it is proposed to ask attention to a brief review of the condition of Mexico ; *first*, from its geographical or natural stand-point, and *secondly*, from the stand-point of its historical, social, and political experience.

Considered geographically, Mexico is, in the main, an immense table-land or plateau, which seems to be a flattening out of the Rocky and Sierra Nevada Mountains, and which, commencing within the territory of the United States as far north certainly as Central Colorado, and perhaps beyond, extends as far south as the Isthmus of Tehuantepec; a north and south length, measuring from the southern frontier-line of the United States, of about two thousand miles. Entering the country by the Mexican Central Railway at El Paso, where the plateau has already an elevation of 3,717 feet, the traveler progressively and rapidly ascends, though so gradually that, except for a *détour*, made obligatory in the construction of the road to climb up into the city of Zacatecas, he is hardly conscious of it until, at a point known as Marquez, 1,148 miles from the starting-point and 76 miles from the city of Mexico, the railroad-track attains an elevation of 8,134 feet, or 1,849 feet higher than the summit of Mount Washington. From this point the line descends 834 feet into the valley of the city of Mexico, the bottom of which is about 7,300 feet above the sea-level. In fact, as Humboldt as far back as 1803 pointed out, so regular is the great plateau on the line followed by the Central road, and so gentle are its surface slopes where depressions occur, that the journey from the city of Mexico to Santa Fé, in New Mexico, might be performed in a four-wheeled vehicle.

Starting next from the city of Mexico, and going east toward the Atlantic, or west toward the Pacific, for a distance in either direction of about one hundred and sixty miles, and we come to the edge or terminus of this great plateau; so well defined and so abrupt that in places it seems as if a single vigorous jump would land the experimenter, or all that was left of him, at from two to three thousand feet lower level. Up the side of this almost precipice—tunneling through or winding round a succession of mountain promontories—the Vera Cruz and City of Mexico Railroad has been constructed; "rising" or "falling"—according to the direction traveled—over four thousand feet, in passing over a circuitous track of about twenty-five miles; and of which elevation or depression about twenty-five hundred perpendicular feet are comprised within the first thirteen miles, measured from the point where the descent from the edge of the plateau begins. To overcome this tremendous grade in ascending, a sort of double locomotive—comprising two sets of driving machinery, with the boilers in the center, and known as the "Farlie" engine—is employed; and even with this most powerful tractor it is necessary, with an ordinary train, to stop every eight or ten miles, in order to keep up a sufficient head of steam to overcome the resistance. In descending, on the other hand, only sufficient steam is necessary to work the brakes and counteract the tendency to a too rapid movement. As an achievement in engineering the road has probably no parallel, except it may be in some of the more recent and limited constructions among the passes of Colorado; and, as might be expected, the cost of transportation over the entire distance of 263 miles, from Vera Cruz to the city of

Mexico, is very heavy, although at an enormous reduction on the cost of all methods previously employed. When the road was first opened, the charges for first-class freight per ton were $76; second class, $65; and by passenger-trains, $97.77. Since the opening of, and under the influence of the competition of, the Mexican Central, these rates have been reduced to an average of about $40 to $45 per ton, and still the business is understood to be not especially remunerative. Begun in 1857, this road was not completed, owing mainly to the disturbed state of the country, until 1873. It was built under English supervision, and with English capital, at a cost, including equipment, of $39,000,000, and is solid and excellent throughout. During the year 1876 the road was destroyed at different points by the revolutionists, and all traffic for a considerable time suspended.

At the station "Esperanza," one hundred and fifty miles from the city of Mexico, on the farther side of a great sandy plain, and on the very verge of the plateau, and where the descent may be said to abruptly begin, the stations, engine-houses, and shops, built of dressed stone, are as massive and elegant as any of the best suburban stations on any of the British railways. And as illustrating how rigidly the English engineers adhered to home rules and precedents, the constructions at this station include a very elegant and expensive arched bridge of dressed stone, with easy and extended approaches, to guard against danger in crossing the tracks; although, apart from the persons in the employ of the company, the resident population is very inconsiderable.

Starting from this point in the early morning of the 27th of March, to make the descent to the comparatively level and low land intervening between the base of the plateau and the ocean, the ground at the station was white with hoar-frost, while behind it, apparently but a mile or two distant, and of not more than fifteen hundred to two thousand feet in elevation, rose the glistening, snow-covered cone of Orizaba. Within the cars, and even with closed windows, overcoats and shawls were essential. Within an hour, however, overcoats and shawls were discarded as uncomfortable. Within another hour the inclination was to get rid of every superfluous garment, while before noon the thermometers in the cars ranged from 90° to 95° Fahr., and the traveler found himself in the heart of the tropics, amid palms, orange-trees, coffee-plantations, fields of sugar-cane and bananas, almost naked Indians, and their picturesque though miserable huts of cane or stakes, plastered with mud and roofed with plantain-leaves or corn-stalks. In the descent, Orizaba (17,373 feet), which at the starting-point, and seen from an elevation of about 8,000 feet, is not impressive in respect to height, although beautiful, gradually rises, and finally, when seen from the level of the low or coast lands, becomes a most magnificent spectacle, far superior to Popocatepetl, which is higher, or any other Mexican mountain, but, in the opinion of the writer, inferior in sublimity to Tacoma in Washington Territory, the entire elevation of which last (14,300 feet) can, in some places, be taken in at a single glance from the sea-level and a water-foreground. The comparatively narrow and gently sloping strip of land which the traveler thus reaches on the Atlantic side in journeying from Mexico to Vera Cruz extends from the base of the great plateau to the ocean, and, with its counterpart on the Pacific side, constitutes in the main the so-called "*Tierras Calientes*" (hot lands), or the tropical part of Mexico. The average width of these coast-lands on the Atlantic is about sixty miles, while on the Pacific it varies from forty to seventy miles.

Considered as a whole, the geographical configuration and position of Mexico have been compared to an immense cornucopia, with its mouth turned toward the United States and its concave side on the Atlantic; having an extreme length of about 2,000 miles, and a varying width of from 1,000 to 130 miles. Its territorial area is 761,791 square miles, or a little larger than that part of the United States, east of the Mississippi River, exclusive of the States of Wisconsin and Mississippi; and this cornucopia in turn, as has been before intimated, consists of an immense table-land, nine tenths of which have an average elevation of from 5,000 to 7,000 feet. Such an elevation in the latitude of 42° (Boston or New York) would have given the country an almost Arctic character; but under the Tropic of Cancer, or in latitudes 18° to 25° north, the climate at these high elevations is almost that of perpetual spring. At these high elevations of the Mexican plateau furthermore, the atmosphere is so lacking in moisture, that meat, bread, or cheese, never molds or putrefies, but only spoils by drying up. Perspiration, even when walking briskly in the middle of the day, does not gather or remain upon the forehead or other exposed portions of the body; and it is only through this peculiarity of the atmosphere that the city of Mexico, with its large population, and its soil reeking with filth through lack of any good and sufficient drainage, has not long ago been desolated with pestilence. As it is, the death-rate of the city is reported to be larger than at almost any of the great centers of the world's population from which sanitary science has been enabled to obtain data.

The surface of this great Mexican plateau, or table-land, although embracing extensive areas of comparatively level surface, which are often deserts, is nevertheless largely broken up by ranges of mountains, or detached peaks—some of which, like Popocatepetl, Orizaba, and Toluca, rise to great elevations—a circumstance which it is important to remember, and will be again referred to, in considering the possible future material development of the country.

Again, if we except certain navigable channels which make up for short distances from the sea into the low, narrow strips of coast-lands, there is not a navigable river in all Mexico; or, indeed, any stream, south of the Rio Grande, that in the United States, east of the Mississippi, would be regarded as of any special importance. In respect, therefore, to this element of commercial prosperity, Mexico has been characterized as less favored than any considerable country except Arabia; the name of which last, as is well known, stands almost as a synonym for aridity.

No one accurately knows the actual population of Mexico, as no accurate census has ever been taken; and there is no immediate prospect that any will be: certainly not so long as a majority of the people have a fear of giving any information in respect to their numbers, as is represented, and a not inconsiderable part of the country, as has already been pointed out, has never yet been brought under the rule of civil authority. The estimate is, however, from ten to twelve million; and of this number, fully nine tenths are believed to be located upon the high or table lands, and only one tenth on the lowlands of the east and west coasts.

So much, then, for Mexico, considered geographically or in respect to its natural conditions. Let us next, as a means of better comprehending its present condition, briefly consider its historical, social, and political experiences.

The authentic history of Mexico practically commences with its conquest and occupation by the Spaniards under Cortes in 1521. The general idea is, that the people whom the Spaniards found in Mexico had attained to a degree of civilization that raised them far above the level of the average Indians of North America, more especially in all that pertained to government, architecture, agriculture, manufactures, and the useful arts, and the production and accumulation of property. For all this there is certainly but very little foundation, and the fascinating narrations of Prescott, which have done so much to make what is popularly considered "Mexican history," as well as the Spanish chronicles from which Prescott drew his so-called historic data, are, in the opinion of the writer, and with the exception of the military record of the Spaniards, little other than the merest romance, not much more worthy, in fact, of respect and credence than the equally fascinating stories of "Sinbad the Sailor." And, in defense and warrant for such an unusual and perhaps unpopular conclusion, attention is asked to the following circumstances and reasons:

In the Museum of the city of Mexico, there is probably the best collection of the remains of the so-called Aztec people that ever has, or probably ever will be gathered. Here, ranged upon shelves and properly classified, the visitor will see a large number and variety of their tools, weapons, and implements. Setting aside their fictile or pottery products, they are all of stone—the same arrow-heads, the same stone hatchets, pestles, and the like, which are still picked up on the fields and along the water-courses of New England, the South, and the West; and of which there are so many public and private collections in the

United States—no better than, and in some respects inferior in artistic merit and finish to, many like articles excavated from the Western mounds, or known to have been the work of our historic Indians; or to the arrow-heads and lance-tips which are still fabricated by the Shoshones and Flatheads on the Columbia and Snake Rivers. In all this large Aztec collection there is not a single metal tool or fabrication, and in only a very few instances have any such articles of unquestionable antique origin ever been found in Mexico. And of the pottery and stone-work in the shape of idols, small and big, masks, and vases, and of which there are many specimens in the museum and throughout the country, it is sufficient to say that it is all of the rudest kind, and derives its chief attraction and interest from its hideousness and almost entire lack of anything which indicates either artistic taste or skill on the part of its fabricators. Take any fair collection of what purports to be the products of Aztec skill and workmanship, and place the same side by side with a similar collection made in any of the most civilized of the islands of the Pacific—the Feejees, the Marquesas, or the Sandwich Islands, or from the tribes that live on Vancouver's Sound, and the superiority of the latter would be at once most evident and unquestionable. In all fairness, therefore, all controversy with the writer's position, if there is any, ought to be considered as settled; for there is no more infallible test and criterion of the civilization and social condition of either a man or a nation than the tools which he or it works with; and stone hatchets and stone arrow-heads are the accompaniments of the stone age and all that pertains thereto, and their use is not compatible with any high degree of civilization or social refinement. But this is not all. It is now generally conceded that the Aztec tribes, that have become famed in history, did not number as many as two hundred and fifty thousand, and that the area of territory to which their rule was mainly confined did not much exceed in area the State of Rhode Island. The first sight of a horse threw them into a panic, and they had no cattle, sheep, swine, dogs, or other domestic animals—save the turkey—of any account. They had no written language, unless the term can be properly applied to rude drawings of a kind similar to those with which the North American Indian ornaments his skin or scratches upon the rocks. It is very doubtful if they had anything which could be regarded as money, and in the absence of beasts of burden, of any system of roads and of wheeled vehicles, or, indeed, of any methods of transportation other than through the muscular power and backs of men, they could have had but little internal trade or commerce. Prescott assigns to the Aztec city of Mexico a population of three hundred thousand, and sixty thousand houses, and abundant fountains and reservoirs of water; but a very brief reflection would seem to make it evident that no such population could have been regularly supported, mainly with bulky agricultural food transported on the backs of men, or in light canoes through canals from the neighboring small salt lakes; or supplied with water sufficient for fountains, drinking, and domestic purposes, through an earthen pipe "of the size of a man's body," brought some miles "from Chapultepec;" the water adjacent to the city being then, as now, salt and unfit for use. What their manufactures could have been, with stone tools and the most primitive machinery, it is not difficult to conjecture. Probably not materially different from what the traveler may yet see at the present day in the case of the Indian woman, who seated by the wayside, with a bundle of wool under her arm and a spindle consisting of a stem of wood, one end resting in a cup formed from the shell of a gourd, dexterously and rapidly draws out and spins a coarse, but not uneven thread. What their architecture was may be inferred from the circumstance that Cortes, with his little band of less than five hundred Spaniards, leveled to the ground three quarters of the city of Tenochtitlan in the seventeen days of his siege; while of the old city of Mexico, with its reported palaces and temples, there is absolutely nothing left which is indicative of having formed a part of any grand or permanent structure.

That there was, antecedent to the Aztecs, in this country of Mexico and Central America, a superior race to which the name of Toltecs or Mayas has been applied, who built the elaborate stone structures of Yucatan and of other portions of Central America, and who, it would seem, must have been acquainted with the use of metals, can not be doubted. At a town called Tula, about fifty miles from Mexico, on the line of the Mexican Central, where the Toltecs are reported to have first settled, the traveler will see on the plaza, the lower half—i. e., from the feet to the waist—of two colossal and rude, sitting figures; also, several perfect cylindrical sections of columns, which were very curiously arranged to fit into and support each other by means of a tenon and mortise, all of stone. The material of which these objects of unquestionably great antiquity are composed, and which all archæologists who have seen them agree are not Mexican or Aztec in their origin, is a very peculiar black basalt, so hard that a steel tool hardly makes an impression upon it. When the same traveler arrives in the city of Mexico, and is shown the three greatest archæological treasures of American origin—namely, the great idol, "Huitzilopochtli," the "Sacrificial Stone," and the so-called "Calendar" stone, now built into one of the outer walls of the cathedral—he might remark that the material of which they are all constructed is the same hard, black stone which constitutes the relics at Tula, and that neither in the large collections of the Museum of Mexico, nor anywhere else, are there any articles, of assumed Aztec origin, composed of like material. Hence an apparently legitimate inference that the latter have a common origin with the constructions at Tula, and are relics of the Toltecs or older nations, and not of the Aztecs.

Again, while much speculation has been had in respect to the origin and use of the mounds of our Western and Southwestern States, it seems to have been overlooked that almost the exact counterparts of these mounds exist to-day in the earth-pyramid of Cholula, near Puebla, and the two pyramids of Teotihuacan, about fifty miles east of the city of Mexico; and that those structures were in use for religious rites and purposes—i. e., "mound-worship"—at the time of the invasion of the country by the Spaniards under Cortes. It seems difficult, therefore, to avoid also this further inference, that there is an intimate connection as to origin and use between all these North American mound-structures, and that they are all the work of substantially one and the same people, who found their last development and, perhaps, origin in Mexico or Central America. In calling attention to these circumstances, and in venturing opinions concerning them, the writer makes no pretension to archæological knowledge, but he simply offers what seem to him the simple, common-sense conclusions which every observer must come to, who does not bring to his eye a capacity for seeing what has been limited by some preconceived theories.

EXTERNAL FORM OF THE MAN-LIKE APES.*

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IN the gorilla, the chimpanzee, and the orang-outang the external form is subject to essential modifications, according to the age and sex. The difference between the sexes is most strongly marked in the gorilla, and these differences are least apparent in the gibbon.

When a young male gorilla is compared with an aged animal of the same species, we are almost tempted to believe that we have to do with two entirely different creatures. While the young male still displays an evident approximation to the human structure, and develops in its bodily habits the same qualities which generally characterize the short-tailed apes of the Old World, with the exception of the baboon, the aged male is otherwise formed. In the latter case the points of resemblance to the human type are far fewer; the aged animal has become a gigantic ape, retaining indeed in the structure of his hands and feet the characteristics of the primates, while the protruding head is something between the muzzle of the baboon, the bear, and the boar. Simultaneously with these remarkable alterations of the external structure there occurs a modification of the skeleton. The skull of an aged male gorilla becomes more prognathous, and the incisor teeth have

* From Anthropoid Apes. By Robert Hartmann. With Sixty-three Illustrations. No. 51, International Scientific Series. New York: D. Appleton & Co., 1886.

almost attained the length of those of lions and tigers. On the upper part of the skull, which is rounded in youth, great bony crests are developed on the crown of the head and on the occiput, and these are supported by the high, spinous processes of the cervical vertebræ, and thus supply the starting-point for the powerful muscles of the neck and jaw. The supraorbital arches are covered with wrinkled skin, and the already savage and indeed revolting appearance of the old gorilla is thereby increased. A comparison of the two illustrations (Figs. 1 and 3) which accompany the text will make this clear.

These distinctions are not so striking in the female as in the male gorilla. Although there is much which is bestial in the appearance of an aged female, yet the crests, so strongly marked in the male, the projecting orbits, and strong muscular pads are absent in the female, as well as the prognathous form of the skull and the length and thickness of the canine teeth. The aged female gorilla is not, in her whole structure, so far removed from the condition of the same sex in youth as is the aged male. The structure of the female has on the whole more in common with the human form. It has been said, and indeed on good authority, that the female type should take the foremost place in the study of the animal structure, since it is the more universal. But H. von Nathusius maintains that we must take both sexes into consideration in the study of domestic animals, since both are needed to determine the breed.* I accept this condition in the scientific study and description of wild animals also, of every kind and species. All that is said of the universal type of the female animal is and must remain in my eyes a mere phrase. Only the accurate observation of males and females, and of young individuals of both sexes, can throw sufficient light on the history of the race. The male animal is the larger, and predominant with respect to the complete development of certain peculiarities of form in the specific organism, since these are doubtfully present in the adult female, and are either altogether absent in the immature young, or only rudimentary.

Let us now consider, in the first place, the prototype of the species, the aged male gorilla in the full strength of his bodily development (Fig. 1). This animal, when standing upright, is more than six feet in height, or two thousand millimetres. The head is three hundred millimetres in length. The occiput appears to be broader below than above, since the upper part slopes like a gabled roof toward the high, longitudinal crest of the vertex. The projecting supraorbital arches start prominently from the upper and central contour of the skull. In this species, as in other apes, and indeed among mammals generally, and especially in the case of the carnivora, ruminants, and multi-ungulates, eyebrows are present. In the gorilla these consist of a rather scanty growth of coal-black bristles, about forty millimetres in length. Beneath the projecting supraorbital arches are the eyes, opening with

* "Vorträge über Viehzucht und Rassenkenntniss," vol. i, p. 61. Berlin, 1872.

somewhat narrow slits, and with lids which display many and deep longitudinal folds. The upper lid is set with longer and thicker eyelashes than the lower. The dark eyes glow between the lids with a ferocious expression.

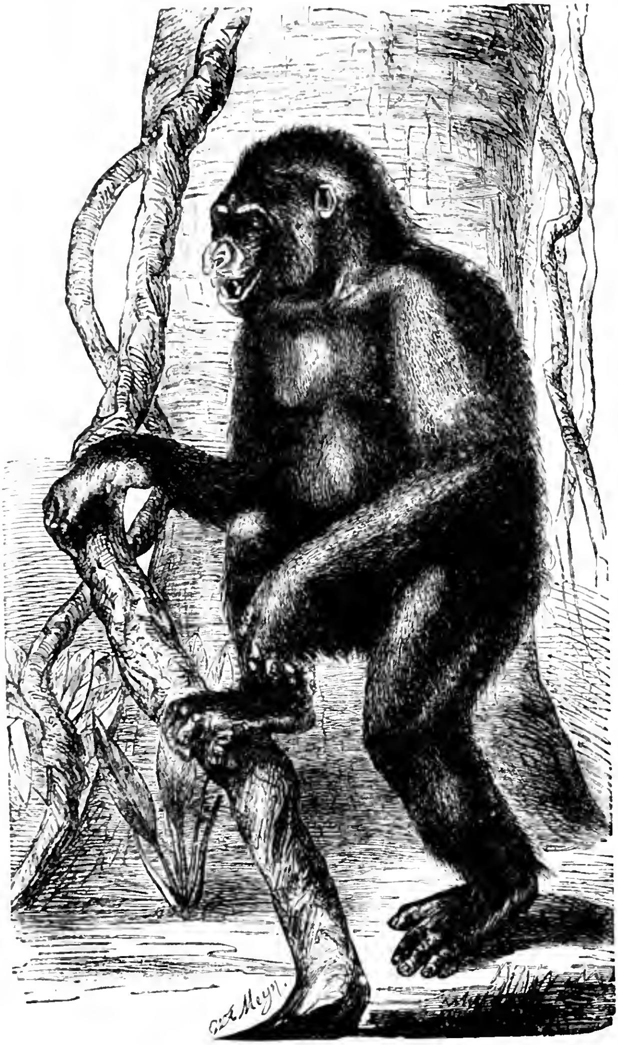

Fig. 1.—Aged Male Gorilla.

The bridge of the nose rises gradually outward, from between the inner corners of the eyes, and is keel-shaped in the center. This part of the head is from seventy to eighty millimetres in length, longer and narrower in one individual, shorter and wider in another. The skin in this region is covered with a net-work of wrinkles of varying size. The end of the nose and the nostrils are high, conical, and very wide at the base. This part of the nose, attached to the very projecting forehead, has the effect of an altogether snout-like muzzle. It is intersected by a central longitudinal furrow, which divides the whole tip of the nose into two symmetrical halves. This furrow is more strongly marked in the case of adult animals than in the young. The aperture of the nostrils is large and triangular, with the cartilaginous point turned upward, and the edges applied to the bridge of the nose and to the cheeks have a somewhat retreating appearance. The lateral margins of this part of the nostril take an arched form, first diverging in different directions, then gradually converging again toward the upper lip. The lip is short, and this, combined with the large nose, gives a certain resemblance to the mouth of an ox. This resemblance is the more striking, as the whole of this region is covered with glandular skin of a deep-black color, which is either glabrous or provided with a few scattered hairs, but furnished with small flattened warts.

Below the eyes the cheeks are broad and very round, dwindling away and becoming depressed in the lower part of the face. They are seamed with curved wrinkles of varying depth, which tend downward in the same direction as the wrinkles on the lower eyelids. The short upper lip is provided with oblique folds which converge outward in the center. The points of the strong canine teeth, which in many individuals are from thirty-eight to forty millimetres long, and twenty millimetres wide, diverge a little from each o.her, and stretch the upper lip in an oblique direction, so that this part of the face takes the form of a triangular, beveled surface, with its prominent base-line between the canine teeth. It may also be observed that, in many individuals of this species, the nose is not very deeply set on the upper lip; that in others, again, the nose is decidedly raised, and the lip only presents a small hem below the nose. In many such cases the prognathism of the face is strongly marked, so as to give a baboon-like effect. In other specimens, again, this debased type is not allied with strongly marked prognathism.

If we take a front view of the skull of an aged male gorilla we see that the upper edges of the great supraorbital arches are beveled off below and at the sides. This beveled form is repeated in the broad cheek-bones, as we see them in front. The front view of the head, and indeed of the whole animal, presents a strongly projecting contour, an impression which is strengthened by the puffed cheeks, with their lateral pads of fat. The lower jaw, with its scarcely indicated chin, retreats in the center and dwindles into a triangular form. This contour is characteristic of the species. The whole skin of the face is glossy, set with few hairs, and of a deep-black color.

The ear (Fig. 2) averages sixty millimetres in length, and from thirty-six to forty millimetres in width. It seems to be fastened to the head by the back and upper part, is generally of an oval shape, and furnished with a strongly marked helix. The helix varies in width in different individuals, and often terminates on its inner edge in the projecting peaked excrescence described by Darwin, of which I shall have more to say presently. The anti-helix, tragus, and anti-tragus, and the cleft which lies between these two latter parts (*incisura inter tragica*) are generally fully developed; the lobule is more rarely present. Individual variations in the special structure of these parts may frequently be observed.

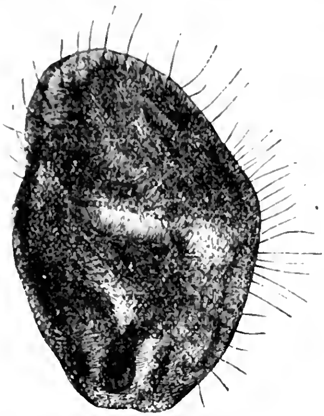

Fig. 2.—Ear of a Male Adult Gorilla.

The strong trapezoid muscles are prominent on the neck, and when the head is stretched they stand out like pillars on the sides of the neck. Owing to the great development of the spinous processes of the cervical vertebræ, and of the muscles attached to them, and to the occipital bones of the skull, the neck is very powerful, almost like that of a bull. The shoulders are remarkable for their breadth, and the pectoral muscles for their large size.

On the upper and forearms the plastic form of the strongly developed flexor and extensor muscles is very apparent, testifying to the enormous strength of the upper extremities. The hands are large, and very wide, with short, thick fingers. The thumb, of which the extremity takes a conical form, is short, extending little beyond the middle of the second metacarpal bone. The extremities of the otherwise broad fingers are somewhat laterally compressed. The fore-finger is not materially shorter than the middle finger. The third finger is sometimes shorter than, sometimes of the same length as, the first, and the fourth is decidedly shorter. The back of the wrist is covered with deep oblique folds. A net-work of wrinkles, oblique or curved, also covers the skin on the back of the fingers, on which there are callosities up to the first joint. The gorilla closes the fingers when going on all-fours, and turns the back of the hand on the ground, thus producing this thickening of the upper skin on the joints. Callosities of the same nature, although not so extensive, are not rare on the second finger-joints. The palm of the hand is covered with a hard, horny skin, generally beset with warts, especially at the roots of the fingers. In spite of the blackness of the skin which covers them, these characteristics are still apparent.

The fingers are united by a strong web, reminding us of the membrane found on the otter and other web-footed animals, and reaching nearly to the first finger-joint. A thick coat of hair extends to the root of the fingers, although on the backs of the fingers there are only a few isolated hairs.

The trunk of the body of a gorilla, seen from behind, somewhat resembles a trapezium in form, of which the longer of the two parallel sides extends between the shoulders, and the shorter between the two halves of the pelvis. The longitudinal sides, which are not parallel, correspond to the sides of the back. The arrangement of all the lower part of the trunk, on which the bones of the pelvis stand out prominently in an oblique direction, somewhat resembles a four-sided pyramid with its apex reversed. The gluteal muscles are not strongly developed. The tuberosity of the ischium projects in a somewhat angular form.

The thighs are covered with strong muscles, which appear to be smoothed off on the inner side, and somewhat arched on the outside. The lower part of the leg is also muscular, and its section is of a long-oval form ; the region of the calf is more strongly developed than in other anthropoids. The bones of the foot are not at all prominent, and the same remark applies to those of the hand. The contour of the back of the long, broad foot is flat ; the sole is convex, covered with strong muscles, and padded with layers of fat. When the animal puts the sole of the foot on the ground, its muscles go back to the region of the heel, and forward into the inner side of the foot, thus presenting the primitive formation of a heel.

The great-toe, as in all apes, is detached like a thumb from the other toes, and can be used as such. The metatarsus serves as a base for its projection, in the same manner as the thumb starts from the fore part of the contour of the wrist. The great-toe sometimes extends as far as the joint between the first and second phalanges of the second toe, sometimes nearly as far as the middle of the second phalanx. This characteristic varies in different individuals. At the point of union of the first metatarsal bone with the hinder extremity of the first phalanx of the great-toe, there is a round projection on the inner side of the foot. The great-toe is very broad at its root, then becomes smaller, and widens again into a broad final phalanx. With its strong lateral ridges of skin, which cover the sinews and cushions of fat, all this part of the foot appears to be wide and flattened off from the back to the sole.

The second, third, fourth, and fifth toes are more slender than the great-toe. The second toe is in most cases rather shorter than the third. The third and fourth toes are almost of the same length, and only a little longer than the second toe.* The fifth toe is considerably shorter than the fourth. The last phalanges of the toes taper in front, and are furnished on their lower surface with long, laterally compressed pads. The section of such a phalanx is almost trapezoidal, with a long upper parallel side. The upper part of the foot, although generally flat, rises a little in the neighborhood of the first metatarsal bone, and slopes thence to its outer edge.

The hair grows thickly on the back of the foot, as far as the ex-

* Compare Isidore Geoffroy Saint-Hilaire, table v ; also Hartmann, "Der Gorilla," p. 14, Anm 4.

tremity of the metatarsal bones, more sparsely on the back of the toes. There are strongly marked oblique furrows on this part of the foot, especially on the joints, often combined with horny callosities, since

Fig. 3.—The Young Male Gorilla, from the Specimen in the Berlin Aquarium of 1876–'77.

the animal sometimes doubles up the toes and runs upon the back of them. The nails of the hands and feet are black, like the whole of their skin-covering, distinctly grooved, very much arched, and generally somewhat wider at the base than in front.

Fig. 4.—The same Animal at a still Earlier Age.

On the sole of the foot we find the region of the heel, the ball of the great-toe, in this case resembling the ball of a thumb, the roots and tips of the toes, together with pads consisting of muscles, tendons, and skin. The several divisions of these padded balls are separated from each other by furrows which are longitudinal, oblique, and transverse, and more or less distinct from each other. The black skin which covers the sole of the foot is thick and horny, but provided with a series of papillæ. The whole skin of an aged animal is of a deep-black color, somewhat glossy, and covered with intersecting wrinkles.

The young male gorilla does not essentially differ from the old male in its general and external appearance. Its skull is, however, without the crest which characterizes the latter animal, and is still of a rounded form in the region of the crown and occiput. At this age the head is not so high at the back and on the top as in aged males. The orbits are less prominent, the general aspect of the face is not so decidedly prognathous, and the bridge of the nose is shorter. The lines of the body in the young male are softer and less exaggerated, and the expression of the face is less ferocious than in an aged male. The horny callosities on the hands and feet are altogether wanting or only faintly indicated, and the hands, fingers, and toes have not arrived at the powerful development which we observe in the older animal.

Considerable differences may be observed in the whole structure of the adult female gorilla. The animals of this sex are smaller and weaker than males of the same age. The skull of the female is smaller and more rounded than that of the male, and the great bony crests are also absent. The orbits are less prominent, and a front view of the head gives the impression of a trapezoidal form. The coronal arch rises above this trapezoid. In the male, on the contrary, the crown seems to lengthen above and behind into a pyramidal form. In the aged female the bridge of the nose is generally shorter than in the aged male; but even in this particular there is great variation in different individuals. Sometimes the bridge of the nose in a female is much depressed, and then the interval between the orbits and the end of the nose is shorter: I intentionally avoid the term *tip* of the nose, on account of the blunted form of this organ. Even when the bridge of the nose is more prominent, the interval between its end and the orbits is sometimes very short.

The aged female gorilla usually has wider cheeks, a smaller nose, and a higher upper lip. This last peculiarity is shown in the correct and well-stuffed specimens in the museums at Paris and Lübeck. Although in the process of drying the skin of the nose may have shrunk a little, yet there is still room for the upper lip, provided with folds which are either vertical and parallel or diverge like a fan. Owen and Mützel* have given satisfactory illustrations of these parts. In the aged female the shape of the neck is not, as in the aged male, strong and bulging, so as to resemble a cowl. Yet it is enlarged in conformity with the not inconsiderable development of the spinous processes of the cervical vertebræ, and with that of the powerful cervical muscles. Even in a young male, of the age of the specimen which was kept in the Berlin Aquarium, between July, 1876, and November, 1877,

* Owen, "Memoir," etc., plate ii; Brehm, "Thierleben," vol. i, p. 56.

this enlargement of the neck was present in a marked degree. In still younger individuals, however, under a year old, in which the spinous processes of the vertebræ have not yet been developed, there is no such enlargement, but, on the contrary, this region of the neck takes a concave form.

In conformity with the smaller size of the body, the shoulders, arms, and thighs of the adult female are smaller than those of the full-grown male, but they are still very powerful. While giving suck, the breasts of the female are swelled in the form of a half-cone, instead of assuming the convex shape which is observed in many European women, and still more frequently in those of the negro, Indian, and South Sea races. The nipple is cylindrical rather than conical in shape, and covered with finely wrinkled black skin, which is sometimes hard and horny. When not giving suck, the breasts hang slackly down, like short empty pouches.

In a young female the cranium is rounded, and the face is only slightly prominent. In aged specimens, especially in those of the male sex, there is a somewhat typical prolongation of that part of the face which lies between the eyes and the end of the nose, and this is to a slight extent apparent in the young female. Variations in form and in the extent of the prolongation are, however, apparent even at this early period. The trunk and limbs are more slenderly built than in a male of the same age.

The hairy coat of the gorilla consists of long, thick, straight or stiffly curved bristles, and also of shorter, thinner, and curled woolly hair. On the crown of the head the hair is somewhat stiff, from twelve to twenty millimetres in length, and it becomes erect under the influence of anger. While the sides and fore part of the chin are only clothed with short, stiff hairs, they grow thickly on the back part of the chin, like a beard or forelock. The hairs which turn outward from the sides of the face and on the neck are thirty or more millimetres in length. On the shoulders the hair is from one hundred and thirty to one hundred and fifty millimetres long, hanging down on the upper arms and the back. In the middle of the upper arm the hair is from fifty to seventy millimetres long, growing downward as far as the bend of the elbow. At this point it generally begins to grow in an upward direction. On the back of the forearm it again grows downward. In the middle of the forearm, on its inner side, a parting of the hairs takes place, as one portion goes in front of the radius, while the other portion turns behind the ulna. On the back of the wrist a tuft of curved hair turns upward ; a middle tuft goes directly back ; and the lower tuft, also curved, turns outward. On the back of the hand the hairs turn toward the fingers. On the breast and belly the hairs are shorter and grow more sparsely. On the breast their direction is, as a rule, upward and outward. On the belly they converge from the ribs toward the center and the navel. On the thighs the hairs are about one hundred and sixty millimetres long, and here, as on the lower part of the leg, they tend outward, while on the back of the foot they grow toward the toes. On the back, shoulders, and on the thigh and leg, the bristles are slightly curved. This quality increases the general impression of shagginess and fleeciness which is produced by the hairy coat of these creatures. The woolly hair does not grow very thick, and is not much matted.

The color of the hair not only differs on different parts of the body, but also in different individuals. On the crown of the head it is of a reddish-brown, or rarely of a decided brown or black. The hairs in this region are sometimes dun-colored at the root, grayish-white in the center, and brownish-red, shading into the dark-brown tip. The hair on the lips is sometimes of a blackish-brown, sometimes whitish, or both colors are found together. The hair growing at the sides of the face is gray below, dark brown or almost black above. On the neck and shoulders the hair is of a gray color at the root, and gradually becomes lighter toward the tip. In the center it is brown, shading into a lighter color at either end; but this ringed form of color is not universal. The tips of the hair are dark, sometimes brown or reddish. The hair on the back, on the upper arms and thighs, is whitish or light gray for half its length, with a blackish-brown ring toward the tip, which is of a dark-gray color. Many of these hairs on the back have two brown rings on them. The forearms, hands, shanks, and feet are covered with hairs which are gray at the root, brownish gray, dark brown, or black at the tip. Round the posteriors there is a circle of white, gray, or brownish-yellow hairs, from ten to twenty millimetres in length. In both sexes variations from the color of the coat here described are not rare. It has been already observed that the brownish-red color of the hair on the head is sometimes exchanged for another shade. In many individuals the neck, shoulders, and back are of a dark gray, brown, or even black color. In others the forearms, hands, shanks, and feet are covered, like the rest of the body, with gray and brown hair intermingled.

The second species of anthropoid apes is the chimpanzee. In this case also we must consider successively the aged and young male, and the aged and young female animals.

The full-grown chimpanzee is smaller than the adult gorilla. In this species also the male is larger than the female. The chimpanzee is, speaking generally, of a slighter build than the gorilla.

The head of the aged male chimpanzee fundamentally differs from that of the aged male gorilla, since the skull of the former has a depressed crown, and the transverse occipital ridge is only faintly indicated. Since the orbits are also less strongly developed than in the aged male gorilla, and the spinous processes of the cervical vertebræ do not assume the same elevated form which is characteristic of the latter species, the countenance of the chimpanzee is not of a square shape, and there is not space for the strong muscular system arching over the neck like a cowl, which is so characteristic of the gorilla. The head of the chimpanzee displays, both in aged and young specimens, the concave neck which is common among apes, that is to say, a depression between the head and the throat. In an aged male the crown of the head presents a rounded, arched contour, since, as we have already said, the prominent bony processes are wanting. Although the supraorbital arches are not so excessively prominent as in a gorilla of the same age, they are strongly developed, covered with wrinkled skin, and in this case also there is a species of eyebrow, stiff and bristly, with shorter hairs between. The large, wrinkled lids are furnished with thick eyelashes. The inner angle of the eye somewhat resembles that of the gorilla.

A general physiognomical distinction between the gorilla and the chimpanzee consists in the fact that the bridge of the nose is shorter in the latter than in the former. In the chimpanzee this part of the organ is depressed, yet the depression is of a conical and convex form, and is covered with a net-work of wrinkles of varying depth. In the chimpanzee the interval between the inner angle of the eye and the upper lateral contour of the cartilaginous end of the nose is shorter than in the gorilla. There is also some difference in the form of the nose: it is on the whole flatter, the tip is less apparent, the nostrils are not so widely opened nor so thickly padded. (Fig. 3.) In the chimpanzee, as well as in the gorilla, a central and vertical furrow directly divides the triangular nostrils, and these are likewise divided from the rest of the face by the broad pear-shaped furrow which surrounds them. The upper lip is generally high, sometimes as high as thirty millimetres; but in some individuals it is much lower. As in the gorilla, the chin forms a triangle of equal sides, with its apex reversed.

The external ear of the chimpanzee has on the whole less resemblance to the human ear, and its contour is larger than that of the gorilla. But this organ varies so much in individuals that it is difficult to lay down any rule for its average size. It ranges from fifty-nine to seventy-seven millimetres in length, and from forty-two to eighty millimetres in width. Many individuals have a distinct lobule to the ear, others not. (Fig. 5.) In this example the helix and anti-helix are developed, in others they are wanting. The tragus and anti-tragus are more or less apparent in different individuals, as well as the other modifications of the external cartilage of the ear.

An aged male chimpanzee has broad, rather rounded shoulders, a powerful chest, long, muscular arms, reaching to the knees, and a long hand, which seems to be very slender in comparison with that of the gorilla. The thumbs vary in length, for the most part reaching as far as the metacarpal phalanges, but not in all cases. The middle finger is longer than the other three; the first and third fingers are shorter by the length of the last phalanx, the third is a little longer than the first, and the fourth is again shorter. A web, which reaches to the middle of the first row of phalanges, stretches between the bases of the four fingers. There are horny callosities on the back of the hand of the aged male, since the chimpanzee, like the gorilla, supports himself on the backs of his closed fingers. The fingers are laterally compressed, but slightly arched on the back of the hand, and more decidedly so on the palm. A net-work of furrows covers the back of the hand, and these are more deeply impressed on its palm. The thumb is separated from the palm by a distinct furrow; and from four to six furrows of varying depth cross the center of the palm. The finger-nails are short, wide, and arched, very convex at their free edges.

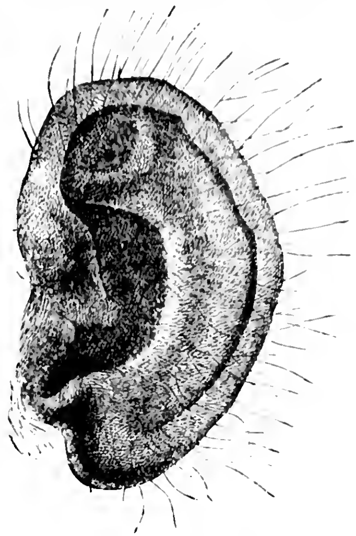

Fig. 5.—Ear of Chimpanzee.

In the aged male the sides of the belly are compressed, the thighs are broad and muscular, and somewhat flattened both on the inner and outer sides. The knees are rather prominent, the shanks are somewhat laterally compressed, and the calf of the leg is very slightly developed. As in the gorilla, the long, wide feet have a thumb-like formation of the great-toes, which are of considerable size. They extend, when drawing anything toward them, as far as the second phalanx of the second toe. The four other toes are more slender, and only a little longer than the great-toe. The heel is but slightly developed, and slopes away below. The joint between the first phalanx of the great-toe and the first metatarsal bone is marked by an angular projection on the inner edge of the foot. The back of the foot is very slightly convex. The last phalanx of the great-toe is very much sloped off on its upper surface, but this is less apparent in the other parts of this member. The last phalanges of the other laterally compressed toes are strongly arched on the under surface. Considerable convexities may also be observed under the metacarpo-phalangeal joint of the great-toe, and under its last phalanx. The shape of the toe-nails resembles that of the fingers. Large callosities are not unfrequently found on the backs of the toes, since the animal sometimes supports himself on these parts. A connective web is found between all the toes, except the great-toe and its neighbor, but it does not extend so far as that between the roots of the fingers.

Although the young male chimpanzee is distinguished from the aged male of the same species by differences in the structure of many of its parts, yet these distinctions are not so characteristic as those between the young and aged male gorillas. The skull of the younger animal, which is altogether devoid of the prominent bony crest and ridges, is shaped almost like a truncated cone in the region of the crown; in some individuals of only a few years old the bony development of the orbits has already begun, starting from the principal part of the frontal bone, and covered with pads of wrinkled skin. The short and depressed bridge of the nose becomes longer and higher, the cartilaginous end of the nose becomes larger, and the prognathism of the face increases with each successive stage of growth. The strength of the trunk and limbs is early developed. The sexual characteristics are gradually and plainly developed; but the male gorilla far exceeds the chimpanzee in demoniacal ferocity.

The adult female is smaller, and has a smaller head, with an oval crown to the skull. The orbits are not so strongly developed as in the aged male, the nasal parts are less prominent, and the teeth are not nearly so strong. The body of an animal of this sex is rounder in all its parts; and the belly, with its wider pelvis, is more tun-shaped than in the aged male. Neither do the limbs display the same angular formation of muscles.* The hands and feet of the female are also smaller and slenderer. In a young female the characteristics here describep are presented in the mitigated form which corresponds with its youthful condition. But the female sometimes becomes a very strong and even violent creature. This was often proved in the Hamburg Zoölogical Garden, where a female specimen, in splendid condition, survived for several years under the faithful care of old Siegel.†

The skin of the chimpanzee is of a peculiar light, yet muddy flesh color, which sometimes verges upon brown. Spots, varying in size and depth of color, sometimes isolated, sometimes in groups, and of a blackish-brown, sooty, or bluish-black tint, are found on different parts of the body of many individuals, especially on the face, neck, breast, belly, arms and hands, thighs and shanks; more rarely on the back. The face, which is soon after birth of a flesh color, merging into a yellowish-brown, assumes a darker shade with the gradual development of the body. The hairy coat is sleek, or only in rare cases slightly curled, and the coarser and bristly hair is generally stiff and elastic. The parting on the forehead is often so regular that it might have been arranged by the hairdresser's art (see Fig. 6). Close behind that part of the head at which the projecting supraorbital ridges of the gorilla generally meet, there is in the chimpanzee an altogether bald place, or only a few scattered hairs. Round the face the growth

* Compare Hartmann, "Der Gorilla," Fig. 8. This is undoubtedly one of the most successful illustrations of the chimpanzee, its habits, expression, and disposition.

† Compare Hartmann, "Der Gorilla," Fig. 27, representing the Hamburg animal in middle age. Fig. 6 gives the wild Paulina of the German Loango expedition. The inscription, by an error of the press, states that it is a male, not a female chimpanzee.

of hair streams downward like a beard. On the neck it is from sixty to eighty or one hundred millimetres in length, and it falls in the same long locks over the shoulders, back, and hips. The hair on the limbs is not so long, and takes a downward direction on the upper arm, and an opposite direction on the forearm, while there is often a longitudinal parting on the center of the inner surface of this part of the limb.

FIG. 6.—YOUNG CHIMPANZEE.

On the back of the wrist the hair grows in a kind of whorl; the upper hairs turn upward and backward, the middle ones turn backward, the lower ones backward and downward. The backs of the hands and the roots of the fingers are hairy. On the front of the thigh the hair takes a downward direction, while behind it grows backward. On the shank it grows downward in the region of the tibia, and turns back on the inside of the leg. The back of the foot and the roots of the toes are likewise hairy. There is a shorter growth of these scattered hairs on the face, chin, and ears. On the supraorbital arches there are from eight to twenty, or even more, stiff, scattered hairs, after the manner of eyebrows; and eyelashes are likewise present.

In most cases the hair of the true chimpanzee is of a black color. Short whitish hairs may be observed on the lower part of the face and chin, as well as round the posteriors. Sometimes the color of the hair is shot throughout with reddish or brownish black.

The orang-outang, the chief representative of the anthropoids in Asia, differs from the African forms of this group, almost at the first glance, in the height of his skull, of which the fore part is compressed and shortened in a backward direction. In the aged male it is, however, provided with high and erect bony crests, which give a prognathous appearance to the countenance. We take an aged male as the type of our description.

The forehead is high and erect, not retreating like that of the chimpanzee; it is open, and has moderately convex frontal eminences. From the center of the forehead a round or bluntly oval eminence sometimes projects. The supraorbital ridges are strongly arched, yet not so prominent as that of the aged male chimpanzee, setting aside that of the gorilla. The eyes are not widely opened, nor are their lids large and furrowed, but on the lower lids there are deep wrinkles. The small bridge of the nose is generally much depressed, but sometimes assumes a slightly conical form as it issues from the central longitudinal depression of the face. The end of the nose, farther removed from the eyes than is generally the case in the chimpanzee, is not so broad as it is in the latter animal and in the gorilla. The wings of the nose are narrow and highly arched in their upper part, divided from each other by a vertical furrow, and the nostrils are small and oval, separated by a thin partition. The upper lip is high, broad, and projecting, and seldom much wrinkled. It is divided from the cheeks and from the upper part of the face by a deep depression; and behind the cheeks two large and long-shaped or sometimes triangular pads of fat often project forward and downward.

The very mobile lips are furrowed, and not remarkably thick. The chin is very retreating, but somewhat uniformly rounded in front (Fig. 7). The small ear averages fifty-five millimetres in length, and twelve millimetres in width, and has a general resemblance in structure to the human ear (Fig. 8). On the fore part of the short, thick neck there are irregular, and in some places very deep, circular folds of skin. The throat-pouch distends part of this slack, wrinkled skin, which hangs down in front like a great empty wallet (see Figs. 7 and 9).

The structure of the other parts of the body lacks even, to some extent, the powerful and symmetrical formation which we observe in the gorilla, and indeed in the chimpanzee. The trunk, with broad yet rather angular and sloping shoulders, with flattened breast, rounded back, and still more rounded belly, is tun-shaped, and gives the impression of a want of proportion. In lean individuals the gluteal region resembles the projecting rump of a fowl, and this may also be observed in the young gorilla and chimpanzee. The long, muscular arms reach to the ankles when the animal is in an erect position, and are altogether out of proportion with the rest of the body. The pow-

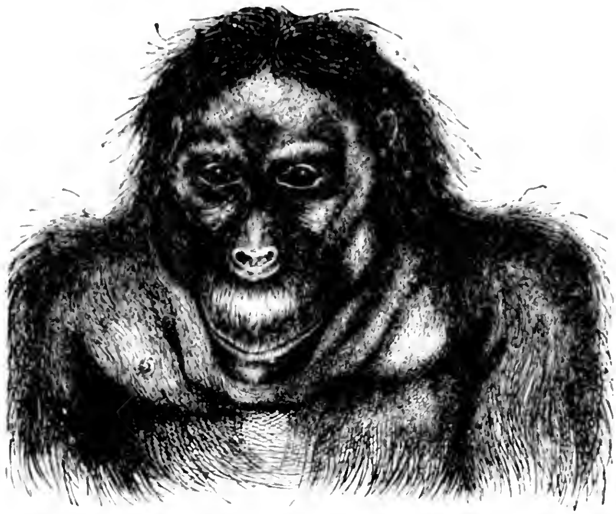

FIG. 7.—HEAD AND SHOULDERS OF AN AGED MALE ORANG-OUTANG.

erful upper arm is shorter than the lean forearm. The hand is long and narrow. The thumb, which reaches as far as the metacarpo-phalangeal joint, has a displeasing and almost rudimentary effect. A web unites the fingers, sometimes extending along a third of the first phalanx, sometimes along half. The middle finger is somewhat longer than the first and third fingers, and the third is next to it in length. The fourth finger is comparatively long. The palm of the hand is flat, only marked by a few deep furrows. The long, slender fingers are laterally compressed, and the nails on their tapering ends are arched.

FIG. 8.—EAR OF THE ORANG-OUTANG.

The thighs, somewhat compressed on the inner side, are, however, very muscular, but become much smaller on their back side. The calf of the leg is less developed than in the gorilla, or even than in the chimpanzee. The feet are, like the hands, long and slender. The narrow, flat heels, project very slightly behind. The great-toes are short, with wide extremities, rounded above, and provided on the sole with thick, fatty skin. In old age these animals not only often lose the nails of their great-toes, but sometimes even the last phalanges themselves. This is not merely a disease produced by confinement, as is the case with sea-cat monkeys, hyenas, etc., which in this condition lose portions of their tails or toes, but it also occurs among orang-outangs in their wild state. The middle toe is the longest, and the fourth toe is the shortest. Layers of fat may be observed on the under side of all but the great-toe, where they rarely occur. The backs of the hands and feet are covered with very ribbed and wrinkled skin, and on the hands there are callosities.

This animal, of a quieter and more phlegmatic disposition than the gorilla and chimpanzee, has a very strange appearance, with its projecting head and short neck; its face widening in the middle and tapering toward the forehead and chin; its tun-shaped trunk, long, thin extremities, and shaggy coat. It differs widely from the chimpanzee and gorilla in these particulars. In the young male the compression of the forehead is less marked than in aged animals, and the bony crests which conduce to raise the coronal arch in its upper and hinder part are also absent. The supraorbital arches are less strongly developed, the jaws are less prominent, and the layers of fat upon the cheeks are absent. The head is more detached from the neck, the structure of the whole body is slenderer, the expression of the countenance is milder. A small, conical nail, blunted at the end, may generally be observed on the great-toe.

In the adult female, as I have pointed out elsewhere, the physical characteristics of the young male are repeated in an exaggerated form. The skull, displaying only very small bony crests, is indeed high, but more rounded than in the aged male; the face is prominent, but the head is more detached from the neck than in the latter case. On account of the greater width of the pelvis, the body is still more tun-shaped than in the aged male. When giving suck, the breasts are distended in the form of a half cone, but when this condition ceases they fall together and only present two short, wrinkled, slightly prominent folds of skin; the small, horny nipples are almost cylindrical; and the areola, of which the traces are scanty at all times, altogether disappears. The throat-pouch is less strongly developed than in the aged male, but the limbs are as fully developed. The head of the young female is still more rounded, with a more flattened though still projecting face, and the limbs are slenderer, and thus still more out of proportion with the thick trunk than is the case with a young male.

The orang-outang's skin is of a grayish-blue color, sometimes mixed with brown, but the grayish-blue shade is predominant. A yellowish or brownish gray is less common. Round the eyes, nostrils, upper lips, and chin, there is often a ring of a dirty, yellowish-brown color, forming a strange contrast with the general bluish-gray tone of the face. The arms, legs, hands, and feet are black or grayish-black, more rarely brown or reddish-brown.

The hairy coat of the orang-outang consists of long, curved, waving bristles, and some scanty downy hairs. On the back of the head, on the shoulders, back, and hips, I have measured hairs from two hundred and twenty to two hundred and thirty-five millimetres in length. In other individuals they were, however, much shorter—twenty, forty, or sixty millimetres long. There is often a natural parting of the hair of the head, which falls asunder on either side. In some cases there is no parting, and the hair streams wildly down; and in others, again, it stands upright, stiffening from the sides and top of the head in a demoniacal manner (Figs. 7 and 9). A beard frequently encircles the

Fig. 9.—Adult Male Orang-Outang.

cheeks and chin. The hair grows upward and outward on the neck and fore part of the throat, on the shoulders, back, breast, belly, upper arms, and thighs, while it takes the opposite direction on the forearm. On the wrist the hair grows in the manner described in the case of the gorilla. There is only a scanty growth of hair on the breast and belly, and it is also short and weak on the face, ears, and backs of the hands and feet. I have not observed eyebrows on the animals I have seen, but they may occur, and the eyelashes are fully developed.

The hair is of a reddish-brown color, something like burnt sienna, and the hair-tips on the back parts of the body are generally brown. In some individuals the hair is darker, of a russet or blackish brown; in others it is lighter, and in the latter case the breast and belly are of a yellowish white. The beard is sometimes dark yellow. Some individuals almost devoid of hair have been observed.

THE FACTORS OF ORGANIC EVOLUTION.

By HERBERT SPENCER.

I.

WITHIN the recollection of men now in middle life, opinion concerning the derivation of animals and plants was in a chaotic state. Among the unthinking there was tacit belief in creation by miracle, which formed an essential part of the creed of Christendom; and among the thinking there were two parties, each of which held an indefensible hypothesis. Immensely the larger of these parties, including nearly all whose scientific culture gave weight to their judgments, though not accepting literally the theologically-orthodox doctrine, made a compromise between that doctrine and the doctrines which geologists had established; while opposed to them were some, mostly having no authority in science, who held a doctrine which was heterodox both theologically and scientifically. Professor Huxley, in his lecture on "The Coming of Age of the Origin of Species," remarks concerning the first of these parties as follows:

"One-and-twenty years ago, in spite of the work commenced by Hutton and continued with rare skill and patience by Lyell, the dominant view of the past history of the earth was catastrophic. Great and sudden physical revolutions, wholesale creations and extinctions of living beings, were the ordinary machinery of the geological epic brought into fashion by the misapplied genius of Cuvier. It was gravely maintained and taught that the end of every geological epoch was signalized by a cataclysm, by which every living being on the globe was swept away, to be replaced by a brand-new creation when the world returned to quiescence. A scheme of nature which appeared to be modelled on the likeness of a succession of rubbers of whist, at the end of each of which the players upset the table and called for a new pack, did not seem to shock anybody.

I may be wrong, but I doubt if, at the present time, there is a single responsible representative of these opinions left. The progress of scientific geology has elevated the fundament principle of uniformitarianism, that the explanation of the past is to be sought in the study of the present, into the position of an axiom; and the wild speculations of the catastrophists, to which we all listened with respect a quarter of a century ago, would hardly find a single patient hearer at the present day."

Of the party above referred to as not satisfied with this conception described by Professor Huxley, there were two classes. The great majority were admirers of the *Vestiges of the Natural History of Creation*—a work which, while it sought to show that organic evolution has taken place, contended that the cause of organic evolution is "an impulse" supernaturally "imparted to the forms of life, advancing them . . . through grades of organization." Being nearly all very inadequately acquainted with the facts, those who accepted the view set forth in the *Vestiges* were ridiculed by the well-instructed for being satisfied with evidence, much of which was either invalid or easily cancelled by counter-evidence, and at the same time they exposed themselves to the ridicule of the more philosophical for being content with a supposed explanation which was in reality no explanation—the alleged "impulse" to advance giving us no more help in understanding the facts than does Nature's alleged "abhorrence of a vacuum" help us to understand the ascent of water in a pump. The remnant, forming the second of these classes, was very small. While rejecting this mere verbal solution, which both Dr. Erasmus Darwin and Lamarck had shadowed forth in other language, there were some few who, rejecting also the hypothesis indicated by both Dr. Darwin and Lamarck, that the promptings of desires or wants produced growths of the parts subserving them, accepted the single *vera causa* assigned by these writers—the modification of structures resulting from modification of functions. They recognized as the sole process in organic development the adaptation of parts and powers consequent on the effects of use and disuse—that continual moulding and remoulding of organisms to suit their circumstances, which is brought about by direct converse with such circumstances.

But while this cause accepted by these few is a true cause, since unquestionably during the life of the individual organism changes of function produce changes of structure; and while it is a tenable hypothesis that changes of structure so produced are inheritable, yet it was manifest to those not prepossessed, that this cause cannot with reason be assigned for the greater part of the facts. Though in plants there are some characters which may not irrationally be ascribed to the direct effects of modified functions consequent on modified circumstances, yet the majority of the traits presented by plants are not to be thus explained. It is impossible that the thorns by which a briar is in large measure defended against browsing animals, can have been developed and moulded by the continuous exercise of their protective actions; for in the first place, the great majority of the thorns are never touched at all, and, in the second place, we have no ground whatever for supposing that those which are touched are thereby made to grow, and to take those shapes which render them efficient. Plants which are rendered uneatable by the thick woolly coatings of their leaves, cannot have had these coatings produced by any process of reaction against the action of enemies; for there is no imaginable reason why, if one part of a plant is eaten, the rest should thereafter begin to develop the hairs on its surface. By what direct effect of function on structure can the shell of a nut have been evolved? Or how can those seeds which contain essential oils, rendering them unpalatable to birds, have been made to secrete such essential oils by these actions of birds which they restrain? Or how can the delicate plumes borne by some seeds, and giving the wind power to waft them to new stations, be due to any immediate influences of surrounding conditions? Clearly in these and in countless other cases, change of structure cannot have been directly caused by change of function. So is it with animals to a large extent, if not to the same extent. Though we have proof that by rough usage the dermal layer may be so excited as to produce a greatly thickened epidermal layer, sometimes quite horny; and though it is a feasible hypothesis that an effect of this kind persistently produced may be inherited; yet no such cause can explain the carapace of the turtle, the armor of the armadillo, or the imbricated covering of the manis. The skins of these animals are no more exposed to habitual hard usage than are those of animals covered by hair. The strange excrescences which distinguish the heads of the hornbills, cannot possibly have arisen from any reaction against the action of surrounding forces; for even were they clearly protective, there is no reason to suppose that the heads of these birds need protection more than the heads of other birds. If, led by the evidence that in animals the amount of covering is in some cases affected by the degree of exposure, it were admitted as imaginable that the development of feathers from preceding dermal growths had resulted from that extra nutrition caused by extra superficial circulation, we should still be without explanation of the structure of a feather. Nor should we have any clue to the specialities of feathers—the crests of various birds, the tails sometimes so enormous, the curiously placed plumes of the bird of paradise, etc. Still more obviously impossible is it to explain as due to use or disuse the colors of animals. No direct adaptation to function could have produced the blue protuberances on a mandril's face, or the striped hide of a tiger, or the gorgeous plumage of a kingfisher, or the eyes in a peacock's tail, or the multitudinous patterns of insects' wings. One single case, that of a deer's horns, might alone have sufficed to show how insufficient was the assigned cause. During their growth, a deer's horns are not used at all; and when, having been cleared of the dead skin and dried-up blood-vessels covering them, they are ready for use, they are nerveless and non-vascular, and hence are incapable of undergoing any changes of structure consequent on changes of function.

Of these few, then, who rejected the belief described by Professor Huxley, and who, espousing the belief in a continuous evolution, had to account for this evolution, it must be said that though the cause assigned was a true cause, yet, even admitting that it operated through successive generations, it left unexplained the greater part of the facts. Obviously the facts that were congruous with the espoused view, monopolized consciousness, and kept out the facts that were incongruous with it—conspicuous though many of them were. The misjudgment was not unnatural. Finding it impossible to accept any doctrine which implied a breach in the uniform course of natural causation, and, by implication, accepting as unquestionable the origin and development of all organic forms by accumulated modifications naturally caused, that which appeared to explain certain classes of these modifications, was supposed to be capable of explaining the rest: the tendency being to assume that these would eventually be similarly accounted for, though it was not clear how.

Returning from this parenthetic remark, we are concerned here chiefly to remember that, as said at the outset, there existed thirty years ago, no tenable theory about the genesis of living things. Of the two alternative beliefs, neither would bear critical examination.

Out of this dead lock we were released—in large measure, though not I believe entirely—by the *Origin of Species*. That work brought into view a further factor; or, rather, such factor, recognized as in operation by here and there an observer (as pointed out by Mr. Darwin in his introduction to the second edition), was by him for the first time seen to have played so immense a part in the genesis of plants and animals.

Though laying myself open to the charge of telling a thrice-told tale, I feel obliged here to indicate briefly the several great classes of facts which Mr. Darwin's hypothesis explains; because otherwise that which follows would scarcely be understood. And I feel the less hesitation in doing this because the hypothesis which it replaced, not very widely known at any time, has of late so completely dropped into the background, that the majority of readers are scarcely aware of its existence, and do not therefore understand the relation between Mr. Darwin's successful interpretation and the preceding unsuccessful attempt at interpretation. Of these classes of facts, four chief ones may be here distinguished.

In the first place, such adjustments as those exemplified above are made comprehensible. Though it is inconceivable that a structure like that of the pitcher-plant could have been produced by accumulated effects of function on structure; yet it is conceivable that successive selections of favorable variations might have produced it; and the like holds of the no less remarkable appliance of the Venus's Fly-trap, or the still more astonishing one of that water-plant by which infant-fish are captured. Though it is impossible to imagine how, by direct influence of increased use, such dermal appendages as a porcupine's quills could have been developed; yet, profiting as the members of a species otherwise defenceless might do by the stiffness of their hairs, rendering them unpleasant morsels to eat, it is a feasible supposition that from successive survivals of individuals thus defended in the greatest degrees, and the consequent growth in successive generations of hairs into bristles, bristles into spines, spines into quills (for all these are homologous), this change could have arisen. In like manner, the odd inflatable bag of the bladder-nosed seal, the curious fishing-rod with its worm-like appendage carried on the head of the *lophius* or angler, the spurs on the wings of certain birds, the weapons of the sword-fish and saw-fish, the wattles of fowls, and numberless such peculiar structures, though by no possibility explicable as due to effects of use or disuse, are explicable as resulting from natural selection operating in one or other way.

In the second place, while showing us how there have arisen countless modifications in the forms, structures, and colors of each part, Mr. Darwin has shown us how, by the establishment of favorable variations, there may arise new parts. Though the first step in the production of horns on the heads of various herbivorous animals, may have been the growth of callosities consequent on the habit of butting—such callosities thus functionally initiated being afterward developed in the most advantageous ways by selection; yet no explanation can be thus given of the sudden appearance of a duplicate set of horns, as occasionally happens in sheep: an addition which, where it proved beneficial, might readily be made a permanent trait by natural selection. Again, the modifications which follow use and disuse can by no possibility account for changes in the numbers of vertebræ; but after recognizing spontaneous, or rather fortuitous, variation as a factor, we can see that where an additional vertebra hence resulting (as in some pigeons) proves beneficial, survival of the fittest may make it a constant character; and there may, by further like additions, be produced extremely long strings of vertebræ, such as snakes show us. Similarly with the mammary glands. It is not an unreasonable supposition that by the effects of greater or less function, inherited through successive generations, these may be enlarged or diminished in size; but it is out of the question to allege such a cause for changes in their numbers. There is no imaginable explanation of these save the establishment by inheritance of spontaneous variations, such as are known to occur in the human race.

So too, in the third place, with certain alterations in the connexions of parts. According to the greater or smaller demands made on this or that limb, the muscles moving it may be augmented or diminished in bulk; and, if there is inheritance of changes so wrought, the limb may, in course of generations, be rendered larger or smaller. But changes in the arrangements or attachments of muscles can not be thus accounted for. It is found, especially at the extremities, that the relations of tendons to bones and to one another are not always the same. Variations in their modes of connexion may occasionally prove advantageous, and may thus become established. Here again, then, we have a class of structural changes to which Mr. Darwin's hypothesis gives us the key, and to which there is no other key.

Once more there are the phenomena of mimicry. Perhaps in a more striking way than any others, these show how traits which seem inexplicable are explicable as due to the more frequent survival of individuals that have varied in favorable ways. We are enabled to understand such marvellous simulations as those of the leaf-insect, those of beetles which "resemble glittering dew-drops upon the leaves;" those of caterpillars, which, when asleep, stretch themselves out so as to look like twigs. And we are shown how there have arisen still more astonishing imitations—those of one insect by another. As Mr. Bates has proved, there are cases in which a species of butterfly, rendered so unpalatable to insectivorous birds by its disagreeable taste that they will not catch it, is simulated in its colors and markings by a species which is structurally quite different—so simulated that even a practised entomologist is liable to be deceived: the explanation being that an original slight resemblance, leading to occasional mistakes on the part of birds, was increased generation after generation by the more frequent escape of the most-like individuals, until the likeness became thus great.

But now, recognizing in full this process brought into clear view by Mr. Darwin, and traced out by him with so much care and skill, can we conclude that, taken alone, it accounts for organic evolution? Has the natural selection of favorable variations been the sole factor? On critically examining the evidence, we shall find reason to think that it by no means explains all that has to be explained. Omitting for the present any consideration of a factor which may be distinguished as primordial, it may be contended that the above-named factor alleged by Dr. Erasmus Darwin and by Lamarck, must be recognized as a co-operator. Utterly inadequate to explain the major part of the facts as is the hypothesis of the inheritance of functionally-produced modifications, yet there is a minor part of the facts, very extensive though less, which must be ascribed to this cause.

When discussing the question more than twenty years ago (*Principles of Biology*, § 166), I instanced the decreased size of the jaws in the civilized races of mankind, as a change not accounted for by the natural selection of favorable variations; since no one of the decrements by which, in thousands of years, this reduction has been effected, could have given to an individual in which it occurred, such advantage as would cause his survival, either through diminished cost of local nutrition or diminished weight to be carried. I did not then exclude, as I might have done, two other imaginable causes. It may be said that there is some organic correlation between increased size of brain and decreased size of jaw: Camper's doctrine of the facial angle being referred to in proof. But this argument may be met by pointing to the many examples of small-jawed people who are also small-brained, and by citing not infrequent cases of individuals remarkable for their mental powers, and at the same time distinguished by jaws not less than the average but greater. Again, if sexual selection be named as a possible cause, there is the reply that, even supposing such slight diminution of jaw as took place in a single generation to have been an attraction, yet the other incentives to choice on the part of men have been too many and great to allow this one to weigh in an adequate degree; while, during the greater portion of the period, choice on the part of women has scarcely operated: in earlier times they were stolen or bought, and in later times mostly coerced by parents. Thus, reconsideration of the facts does not show me the invalidity of the conclusion drawn, that this decrease in size of jaw can have had no other cause than continued inheritance of those diminutions consequent on diminutions of function, implied by the use of selected and well-prepared food. Here, however, my chief purpose is to add an instance showing, even more clearly, the connexion between change of function and change of structure. This instance, allied in nature to the other, is presented by those varieties, or rather subvarieties, of dogs, which, having been household pets, and habitually fed on soft food, have not been called on to use their jaws in tearing and crunching, and have been but rarely allowed to use them in catching prey and in fighting. No inference can be drawn from the sizes of the jaws themselves, which, in these dogs, have probably been shortened mainly by selection. To get direct proof of the decrease of the muscles concerned in closing the jaws or biting, would require a series of observations very difficult to make. But it is not difficult to get indirect proof of this decrease by looking at the bony structures with which these muscles are connected. Examination of the skulls of sundry indoor dogs contained in the Museum of the College of Surgeons, proves the relative smallness of such parts. The only pug-dog's skull is that of an individual not perfectly adult; and though its traits are quite to the point they cannot with safety be taken as evidence. The skull of a toy-terrier has much restricted areas of insertion for the temporal muscles; has weak zygomatic arches; and has extremely small attachments for the masseter muscles. Still more significant is the evidence furnished by the skull of a King Charles's spaniel, which, if we allow three years to a generation, and bear in mind that the variety must have existed before Charles the Second's reign, we may assume belongs to something approaching to the hundredth generation of these household pets. The relative breadth between the outer surfaces of the zygomatic arches is conspicuously small; the narrowness of the temporal fossæ is also striking; the zygomata are very slender; the temporal muscles have left no marks whatever, either by limiting lines or by the character of the surfaces covered; and the places of attachment for the masseter muscles are very feebly developed. At the Museum of Natural History, among skulls of dogs there is one which, though unnamed, is shown by its small size and by its teeth, to have belonged to one variety or other of lap-dogs, and which has the same traits in an equal degree with the skull just described. Here, then, we have two if not three kinds of dogs which, similarly leading protected and pampered lives, show that in the course of generations the parts concerned in clenching the jaws have dwindled. To what cause must this decrease be ascribed? Certainly not to artificial selection; for most of the modifications named make no appreciable external signs: the width across the zygomata could alone be perceived. Neither can natural selection have had anything to do with it; for even were there any struggle for existence among such dogs, it cannot be contended that any advantage in the struggle could be gained by an individual in which a decrease took place. Economy of nutrition, too, is excluded. Abundantly fed as such dogs are, the constitutional tendency is to find places where excess of absorbed nutriment may be conveniently deposited, rather than to find places where some cutting down of the supplies is practicable. Nor again can there be alleged a possible correlation between these diminutions and that shortening of the jaws which has probably resulted from selection; for in the bull-dog, which has also relatively short jaws, these structures concerned in closing them are unusually large. Thus there remains as the only conceivable cause, the diminution of size which results from diminished use. The dwindling of a little-exercised part has, by inheritance, been made more and more marked in successive generations.

Difficulties of another class may next be exemplified—those which present themselves when we ask how there can be effected by the selection of favorable variations, such changes of structure as adapt an organism to some useful action in which many different parts co-operate. None can fail to see how a simple part may, in course of generations, be greatly enlarged, if each enlargement furthers, in some decided way, maintenance of the species. It is easy to understand, too, how a complex part, as an entire limb, may be increased as a whole by the simultaneous due increase of its co-operative parts; since if, while it is growing, the channels of supply bring to the limb an unusual quantity of blood, there will naturally result a proportionately greater size of all its components—bones, muscles, arteries, veins, etc. But though in cases like this, the co-operative parts forming some large complex part may be expected to vary together, nothing implies that they necessarily do so; and we have proof that in various cases, even when closely united, they do not do so. An example is furnished by those blind crabs named in the *Origin of Species* which inhabit certain dark caves of Kentucky, and which, though they have lost their eyes, have not lost the foot-stalks which carried their eyes. In describing the varieties which have been produced by pigeon-fanciers, Mr. Darwin notes the fact that along with changes in length of beak produced by selection, there have not gone proportionate changes in length of tongue. Take again the case of teeth and jaws. In mankind these have not varied together. During civilization the jaws have decreased, but the teeth have not decreased in proportion; and hence that prevalent crowding of them, often remedied in childhood by extraction of some, and in other cases causing that imperfect development which is followed by early decay. But the absence of proportionate variation in co-operative parts that are close together, and are even bound up in the same mass, is best seen in those varieties of dogs named above as illustrating the inherited effects of disuse. We see in them, as we see in the human race, that diminution in the jaws has not been accompanied by corresponding diminution in the teeth. In the catalogue of the College of Surgeons Museum, there are appended to the entry which identifies a Blenheim Spaniel's skull, the words—"the teeth are closely crowded together," and to the entry concerning the skull of a King Charles's Spaniel the words—"the teeth are closely packed, p. 3, is placed quite transversely to the axis of the skull." It is further noteworthy that in a case where there is no diminished use of the jaws, but where they have been shortened by selection, a like want of concomitant variation is manifested: the case being that of the bull-dog, in the upper jaw of which also, "the premolars . . . are excessively crowded, and placed obliquely or even transversely to the long axis of the skull." *

If, then, in cases where we can test it, we find no concomitant variation in co-operative parts that are near together—if we do not find it in parts which, though belonging to different tissues, are so closely united as teeth and jaws—if we do not find it even when the co-operative parts are not only closely united, but are formed out of the same tissue, like the crab's eye and its peduncle; what shall we say of co-operative parts which, besides being composed of different tissues, are remote from one another? Not only are we forbidden to

* It is probable that this shortening has resulted not directly but indirectly, from the selection of individuals which were noted for tenacity of hold; for the bull-dog's peculiarity in this respect seems due to relative shortness of the upper jaw, giving the underhung structure which, involving retreat of the nostrils, enables the dog to continue breathing while holding.

assume that they vary together, but we are warranted in asserting that they can have no tendency to vary together. And what are the implications in cases where increase of a structure can be of no service unless there is concomitant increase in many distant structures, which have to join it in performing the action for which it is useful?

As far back as 1864 (*Principles of Biology*, § 166) I named in illustration an animal carrying heavy horns—the extinct Irish elk; and indicated the many changes in bones, muscles, blood-vessels, nerves, composing the fore-part of the body, which would be required to make an increment of size in such horns advantageous. Here let me take another instance—that of the giraffe: an instance which I take partly because, in the sixth edition of the *Origin of Species*, issued in 1872, Mr. Darwin has referred to this animal when effectually disposing of certain arguments urged against his hypothesis. He there says:

> "In order that an animal should acquire some structure specially and largely developed, it is almost indispensable that several other parts should be modified and co-adapted. Although every part of the body varies slightly, it does not follow that the necessary parts should always vary in the right direction and to the right degree" (p. 179).

And in the summary of the chapter, he remarks concerning the adjustments in the same quadruped, that "the prolonged use of all the parts together with inheritance will have aided in an important manner in their co-ordination" (p. 199): a remark probably having reference chiefly to the increased massiveness of the lower part of the neck; the increased size and strength of the thorax required to bear the additional burden; and the increased strength of the fore-legs required to carry the greater weight of both. But now I think that further consideration suggests the belief that the entailed modifications are much more numerous and remote than at first appears; and that the greater part of these are such as cannot be ascribed in any degree to the selection of favorable variations, but must be ascribed exclusively to the inherited effects of changed functions. Whoever has seen a giraffe gallop will long remember the sight as a ludicrous one. The reason for the strangeness of the motions is obvious. Though the fore-limbs and the hind-limbs differ so much in length, yet in galloping they have to keep pace—must take equal strides. The result is that at each stride, the angle which the hind-limbs describe round their centre of motion is much larger than the angle described by the fore-limbs. And beyond this, as an aid in equalizing the strides, the hind part of the back is at each stride bent very much downward and forward. Hence the hind-quarters appear to be doing nearly all the work. Now a moment's observation shows that the bones and muscles composing the hind-quarters of the giraffe, perform actions differing in one or other way and degree, from the actions performed by the homologous bones and muscles in a mammal of ordinary proportions, and from those in the ancestral mammal which gave origin to the giraffe. Each further stage of that growth which produced the large fore-quarters and neck, entailed some adapted change in sundry of the numerous parts composing the hind-quarters; since any failure in the adjustment of their respective strengths would entail some defect in speed and consequent loss of life when chased. It needs but to remember how, when continuing to walk with a blistered foot, the taking of steps in such a modified way as to diminish pressure on the sore point, soon produces aching of muscles which are called into unusual action, to see that over-straining of any one of the muscles of the giraffe's hind-quarters might quickly incapacitate the animal when putting out all its powers to escape; and to be a few yards behind others would cause death. Hence if we are debarred from assuming that co-operative parts vary together even when adjacent and closely united—if we are still more debarred from assuming that with increased length of fore-legs or of neck, there will go an appropriate change in any one muscle or bone in the hind-quarters; how entirely out of the question it is to assume that there will simultaneously take place the appropriate changes in *all* those many components of the hind-quarters which severally require re-adjustment. It is useless to reply that an increment of length in the fore-legs or neck might be retained and transmitted to posterity, waiting an appropriate variation in a particular bone or muscle in the hind-quarters, which, being made, would allow of a further increment. For besides the fact that until this secondary variation occurred the primary variation would be a disadvantage often fatal; and besides the fact that before such an appropriate secondary variation might be expected in the course of generations to occur, the primary variation would have died out; there is the fact that the appropriate variation of one bone or muscle in the hind-quarters would be useless without appropriate variations of all the rest—some in this way and some in that—a number of appropriate variations which it is impossible to suppose.

Nor is this all. Far more numerous appropriate variations would be indirectly necessitated. The immense change in the ratio of fore-quarters to hind-quarters would make requisite a corresponding change of ratio in the appliances carrying on the nutrition of the two. The entire vascular system, arterial and veinous, would have to undergo successive unbuildings and rebuildings to make its channels everywhere adequate to the local requirements; since any want of adjustment in the blood-supply in this or that set of muscles, would entail incapacity, failure of speed, and loss of life. Moreover, the nerves supplying the various sets of muscles would have to be proportionately changed; as well as the central nervous tracts from which they issued. Can we suppose that all these appropriate changes, too, would be step by step simultaneously made by fortunate spontaneous variations, occurring along with all the other fortunate spontaneous variations? Considering how immense must be the number of these required changes, added to the changes above enumerated, the chances against any adequate re-adjustments fortuitously arising must be infinity to one.

If the effects of use and disuse of parts are inheritable, then any change in the fore parts of the giraffe which affects the action of the hind-limbs and back, will simultaneously cause, by the greater or less exercise of it, a re-moulding of each component in the hind-limbs and back in a way adapted to the new demands; and generation after generation the entire structure of the hind-quarters will be progressively fitted to the changed structure of the fore-quarters: all the appliances for nutrition and innervation being at the same time progressively fitted to both. But in the absence of this inheritance of functionally-produced modifications, there is no seeing how the required re-adjustments can be made.

Yet a third class of difficulties stands in the way of the belief that the natural selection of useful variations is the sole factor of organic evolution. This class of difficulties, already pointed out in § 166 of the *Principles of Biology*, I cannot more clearly set forth than in the words there used. Hence I may perhaps be excused for here quoting them:

"Where the life is comparatively simple, or where surrounding circumstances render some one function supremely important, the survival of the fittest may readily bring about the appropriate structural change, without any aid from the transmission of functionally-acquired modifications. But in proportion as the life grows complex—in proportion as a healthy existence cannot be secured by a large endowment of some one power, but demands many powers; in the same proportion do there arise obstacles to the increase of any particular power, by "the preservation of favored races in the struggle for life." As fast as the faculties are multiplied, so fast does it become possible for the several members of a species to have various kinds of superiorities over one another. While one saves its life by higher speed, another does the like by clearer vision, another by keener scent, another by quicker hearing, another by greater strength, another by unusual power of enduring cold or hunger, another by special sagacity, another by special timidity, another by special courage; and others by other bodily and mental attributes. Now it is unquestionably true that, other things equal, each of these attributes, giving its possessor an extra chance of life, is likely to be transmitted to posterity. But there seems no reason to suppose that it will be increased in subsequent generations by natural selection. That it may be thus increased, the individuals not possessing more than average endowments of it, must be more frequently killed off than individuals highly endowed with it; and this can happen only when the attribute is one of greater importance, for the time being, than most of the other attributes. If those members of the species which have but ordinary shares of it, nevertheless survive by virtue of other superiorities which they severally possess; then it is not easy to see how this particular attribute can be developed by natural selection in subsequent generations. The probability seems rather to be, that by gamogenesis, this extra endowment will, on the average, be diminished in posterity—just serving in the long run to compensate the deficient endowments of other individuals, whose special powers lie in other directions; and so to keep up the normal structure of the species. The working out of the process is here somewhat difficult to follow; but it appears to me that as fast as the number of bodily and mental faculties increases, and as fast as the maintenance of life comes to depend less on the amount of any one, and more on the combined action of all; so fast does the production of specialities of character by natural selection alone, become difficult. Particularly does this seem to be so with a species so multitudinous in its powers as mankind; and above all does it seem to be so with such of the human powers as have but minor shares in aiding the struggle for life—the æsthetic faculties, for example."

Dwelling for a moment on this last illustration of the class of difficulties described, let us ask how we are to interpret the development of the musical faculty. I will not enlarge on the family antecedents of the great composers. I will merely suggest the inquiry whether the greater powers possessed by Beethoven and Mozart, by Weber and Rossini, than by their fathers, were not due in larger measure to the inherited effects of daily exercise of the musical faculty by their fathers, than to inheritance, with increase, of spontaneous variations; and whether the diffused musical powers of the Bach clan, culminating in those of Johann Sebastian, did not result in part from constant practice; but I will raise the more general question—How came there that endowment of musical faculty which characterizes modern Europeans at large, as compared with their remote ancestors? The monotonous chants of low savages cannot be said to show any melodic inspiration; and it is not evident that an individual savage who had a little more musical perception than the rest, would derive any such advantage in the maintenance of life as would secure the spread of his superiority by inheritance of the variation. And then what are we to say of harmony? We cannot suppose that the appreciation of this, which is relatively modern, can have arisen by descent from the men in whom successive variations increased the appreciation of it—the composers and musical performers; for on the whole, these have been men whose worldly prosperity was not such as enabled them to rear many children inheriting their special traits. Even if we count the illegitimate ones, the survivors of these added to the survivors of the legitimate ones, can hardly be held to have yielded more than average numbers of descendants; and those who inherited their special traits have not often been thereby so aided in the struggle for existence as to further the spread of such traits. Rather the tendency seems to have been the reverse.

Since the above passage was written, I have found in the second volume of *Animals and Plants under Domestication*, a remark made by Mr. Darwin, practically implying that among creatures which depend for their lives on the efficiency of numerous powers, the increase of any one by the natural selection of a variation is necessarily difficult. Here it is:

"Finally, as indefinite and almost illimitable variability is the usual result of domestication and cultivation, with the same part or organ varying in different individuals in different or even in directly opposite ways; and as the same variation, if strongly pronounced, usually recurs only after long intervals of time, any particular variation would generally be lost by crossing, reversion, and the accidental destruction of the varying individuals, unless carefully preserved by man."—Vol. ii, 292.

Remembering that mankind, subject as they are to this domestication and cultivation, are not, like domesticated animals, under an agency which picks out and preserves particular variations; it results that there must usually be among them, under the influence of natural selection alone, a continual disappearance of any useful variations of particular faculties which may arise. Only in cases of variations which are specially preservative, as, for example, great cunning during a relatively barbarous state, can we expect increase from natural selection alone. We cannot suppose that minor traits, exemplified among others by the æsthetic perceptions, can have been evolved by natural selection. But if there is inheritance of functionally-produced modifications of structure, evolution of such minor traits is no longer inexplicable.

Two remarks made by Mr. Darwin have implications from which the same general conclusion must, I think, be drawn. Speaking of the variability of animals and plants under domestication, he says:

"Changes of any kind in the conditions of life, even extremely slight changes, often suffice to cause variability. . . . Animals and plants continue to be variable for an immense period after their first domestication; . . . In the course of time they can be habituated to certain changes, so as to become less variable; . . . There is good evidence that the power of changed conditions accumulates; so that two, three, or more generations must be exposed to new conditions before any effect is visible. . . . Some variations are induced by the direct action of the surrounding conditions on the whole organization, or on certain parts alone, and other variations are induced indirectly through the reproductive system being affected in the same manner as is so common with organic beings when removed from their natural conditions."—(*Animals and Plants under Domestication*, vol. ii, 270.)

There are to be recognized two modes of this effect produced by changed conditions on the reproductive system, and consequently on offspring. Simple arrest of development is one. But beyond the variations of offspring arising from imperfectly-developed reproductive systems in parents—variations which must be ordinarily in the nature of imperfections—there are others due to a changed balance of functions caused by changed conditions. The fact noted by Mr. Darwin in the above passage, that "the power of changed conditions accumulates; so that two, three, or more generations must be exposed to new conditions before any effect is visible," implies that during these generations there is going on some change of constitution consequent on the changed proportions and relations of the functions. I will not dwell on the implication, which seems tolerably clear, that this change must consist of such modifications of organs as adapt them to their changed functions; and that if the influence of changed conditions "accumulates," it must be through the inheritance of such modifications. Nor will I press the question—What is the nature of the effect registered in the reproductive elements, and which is subsequently manifested by variations?—Is it an effect entirely irrelevant to the new requirements of the variety?—Or is it an effect which makes the variety less fit for the new requirements?—Or is it an effect which makes it more fit for the new requirements? But not pressing these questions, it suffices to point out the necessary implication that changed functions of organs *do*, in some way or other, register themselves in changed proclivities of the reproductive elements. In face of these facts it cannot be denied that the modified action of a part produces an inheritable effect—be the nature of that effect what it may.

The second of the remarks above adverted to as made by Mr. Darwin, is contained in his sections dealing with correlated variations. In the *Origin of Species*, p. 114, he says:

"The whole organization is so tied together during its growth and development, that when slight variations in any one part occur, and are accumulated through natural selection, other parts become modified."

And a parallel statement contained in *Animals and Plants under Domestication*, vol. ii, p. 320, runs thus:

"Correlated variation is an important subject for us; for when one part is modified through continued selection, either by man or under nature, other parts of the organization will be unavoidably modified. From this correlation it apparently follows that, with our domesticated animals and plants, varieties rarely or never differ from each other by some single character alone."

By what process does a changed part modify other parts? By modifying their functions in some way or degree, seems the necessary answer. It is indeed, imaginable, that where the part changed is some dermal appendage which, becoming larger, has abstracted more of the needful material from the general stock, the effect may consist simply in diminishing the amount of this material available for other dermal appendages, leading to diminution of some or all of them, and may fail to affect in appreciable ways the rest of the organism: save perhaps the blood-vessels near the enlarged appendage. But where the part is an active one—a limb, or viscus, or any organ which constantly demands blood, produces waste matter, secretes, or absorbs—then all the other active organs become implicated in the change. The functions performed by them have to constitute a moving equilibrium; and the function of one cannot, by alteration of the structure performing it, be modified in degree or kind, without modifying the functions of the rest—some appreciably and others inappreciably, according to the directness or indirectness of their relations. Of such inter-dependent changes, the normal ones are naturally inconspicuous; but those which are partially or completely abnormal, sufficiently carry home the general truth. Thus, unusual cerebral excitement affects the excretion through the kidneys in quantity or quality or both. Strong emotions of disagreeable kinds check or arrest the flow of bile. A considerable obstacle to the circulation offered by some important structure in a diseased or disordered state, throwing more strain upon the heart, causes hypertrophy of its muscular walls; and this change which is, so far as concerns the primary evil, a remedial one, often entails mischiefs in other organs. "Apoplexy and palsy, in a scarcely credible number of cases, are directly dependent on hypertropic enlargement of the heart." And in other cases, asthma, dropsy, and epilepsy are caused. Now if a result of this inter-dependence as seen in the individual organism, is that a local modification of one part produces, by changing their functions, correlative modifications of other parts, then the question here to be put is—Are these correlative modifications, when of a kind falling within normal limits, inheritable or not? If they are inheritable, then the fact stated by Mr. Darwin that "when one part is modified through continued selection," "other parts of the organization will be unavoidably modified" is perfectly intelligible: these entailed secondary modifications are transmitted *pari passu* with the successive modifications produced by selection. But what if they are not inheritable? Then these secondary modifications caused in the individual, not being transmitted to descendants, the descendants must commence life with organizations out of balance, and with each increment of change in the part affected by selection, their organizations must get more out of balance—must have larger and larger amounts of re-organization to be made during their lives. Hence the constitution of the variety must become more and more unworkable.

The only imaginable alternative is that the re-adjustments are effected in course of time by natural selection. But, in the first place, as we find no proof of concomitant variation among directly co-operative parts which are closely united, there cannot be assumed any concomitant variation among parts which are both indirectly co-operative and far from one another. And, in the second place, before all the many required re-adjustments could be made, the variety would die out from defective constitution. Even were there no such difficulty, we should still have to entertain a strange group of propositions, which would stand as follows: 1. Change in one part entails, by reaction on the organism, changes, in other parts, the functions of which are necessarily changed. 2. Such changes worked in the individual, affect, in some way, the reproductive elements: these being found to evolve unusual structures when the constitutional balance has been continuously disturbed. 3. But the changes in the reproductive elements thus caused, are not such as represent these functionally-produced changes: the modifications conveyed to offspring are irrelevant to these various modifications functionally produced in the organs of the parents. 4. Nevertheless, while the balance of functions cannot be re-established through inheritance of the effects of disturbed functions on structures, wrought throughout the individual organism; it can be re-established by the inheritance of fortuitous variations which occur in all the affected organs without reference to these changes of function.

Now without saying that acceptance of this group of propositions is impossible, we may certainly say that it is not easy.

"But where are the direct proofs that inheritance of functionally-produced modifications takes place?" is a question which will be put by those who have committed themselves to the current exclusive interpretation. "Grant that there are difficulties; still, before the transmitted effects of use and disuse can be legitimately assigned in explanation of them, we must have good evidence that the effects of use and disuse *are* transmitted."

Before dealing directly with this demurrer, let me deal with it indirectly, by pointing out that the lack of recognized evidence may be accounted for without assuming that there is not plenty of it. Inattention and reluctant attention lead to the ignoring of facts which really exist in abundance; as is well illustrated in the case of pre-historic implements. Biassed by the current belief that no traces of man were to be found on the Earth's surface, save in certain superficial formations of very recent date, geologists and anthropologists not only neglected to seek such traces, but for a long time continued to pooh-pooh those who said they had found them. When M. Boucher de Perthes at length succeeded in drawing the eyes of scientific men to the flint implements discovered by him in the quaternary deposits of the Somme valley; and when geologists and anthropologists had thus been convinced that evidences of human existence were to be found in formations of considerable age, and thereafter began to search for them; they found plenty of them all over the world. Or again, to take an instance closely germane to the matter, we may recall the fact that the contemptuous attitude toward the hypothesis of organic evolution which naturalists in general maintained before the publication of Mr. Darwin's work, prevented them from seeing the multitudinous facts by which it is supported. Similarly, it is very possible that their alienation from the belief that there is a transmission of those changes of structure which are produced by changes of action, makes naturalists slight the evidence which supports that belief and refuse to occupy themselves in seeking further evidence.

If it be asked how it happens that there have been recorded multitudinous instances of variations fortuitously arising and reappearing in offspring, while there have not been recorded instances of the transmission of changes functionally produced, there are three replies. The first is that changes of the one class are many of them conspicuous, while those of the other class are nearly all inconspicuous. If a child is born with six fingers, the anomaly is not simply obvious but so startling as to attract much notice; and if this child, growing up, has six-fingered descendants, everybody in the locality hears of it. A pigeon with specially-colored feathers, or one distinguished by a broadened and upraised tail, or by a protuberance of the neck, draws attention by its oddness; and if in its young the trait is repeated, occasionally with increase, the fact is remarked, and there follows the thought of establishing the peculiarity by selection. A lamb disabled from leaping by the shortness of its legs, could not fail to be observed; and the fact that its offspring were similarly short-legged, and had a consequent inability to get over fences, would inevitably become widely known. Similarly with plants. That this flower had an extra number of petals, that that was unusually symmetrical, and that another differed considerably in color from the average of its kind, would be easily seen by an observant gardener; and the suspicion that such anomalies are inheritable having arisen, experiments leading to further proofs that they are so, would frequently be made. But it is not thus with functionally-produced modifications. The seats of these are in nearly all cases the muscular, osseous, and nervous systems, and the viscera—parts which are either entirely hidden or greatly obscured. Modification in a nervous centre is inaccessible to vision; bones may be considerably altered in size or shape without attention being drawn to them; and, covered with thick coats as are most of the animals open to continuous observation, the increases or decreases in muscles must be great before they become externally perceptible.

A further important difference between the two inquiries is that to ascertain whether a fortuitous variation is inheritable, needs merely a little attention to the selection of individuals and the observation of offspring; while to ascertain whether there is inheritance of a functionally-produced modification, it is requisite to make arrangements which demand the greater or smaller exercise of some part or parts; and it is difficult in many cases to find such arrangements, troublesome to maintain them even for one generation, and still more through successive generations.

Nor is this all. There exist stimuli to inquiry in the one case which do not exist in the other. The money-interest and the interest of the fancier, acting now separately and now together, have prompted multitudinous individuals to make experiments which have brought out clear evidence that fortuitous variations are inherited. The cattle-breeders who profit by producing certain shapes and qualities; the keepers of pet animals who take pride in the perfections of those they have bred; the florists, professional and amateur, who obtain new varieties and take prizes; form a body of men who furnish naturalists with countless of the required proofs. But there is no such body of men, led either by pecuniary interest or the interest of a hobby, to ascertain by experiments whether the effects of use and disuse are inheritable.

Thus, then, there are amply sufficient reasons why there is a great deal of direct evidence in the one case and but little in the other—such little being that which comes out incidentally. Let us look at what there is of it.

Considerable weight attaches to a fact which Brown-Séquard discovered, quite by accident, in the course of his researches. He found that certain artificially-produced lesions of the nervous system, so small even as a section of the sciatic nerve, left, after healing, an increasing excitability which ended in liability to epilepsy; and there afterward came out the unlooked-for result that the offspring of guinea-pigs which had thus acquired an epileptic habit such that a pinch on the neck would produce a fit, inherited an epileptic habit of like kind. It has, indeed, been since alleged that guinea-pigs tend to epilepsy, and that phenomena of the kind described occur where there have been no antecedents like those in Brown-Séquard's case. But considering the improbability that the phenomena observed by him happened to be nothing more than phenomena which occasionally arise naturally, we may, until there is good proof to the contrary, assign some value to his results.

Evidence not of this directly experimental kind, but nevertheless of considerable weight, is furnished by other nervous disorders. There is proof enough that insanity admits of being induced by circumstances which, in one or other way, derange the nervous functions—excesses of this or that kind; and no one questions the accepted belief that insanity is inheritable. Is it alleged that the insanity which is inheritable is that which spontaneously arises, and that the insanity which follows some chronic perversion of functions is not inheritable? This does not seem a very reasonable allegation, and until some warrant for it is forthcoming, we may fairly assume that there is here a further support for belief in the transmission of functionally-produced changes.

Moreover, I find among physicians the belief that nervous disorders of a less severe kind are inheritable. Men who have prostrated their nervous systems by prolonged overwork or in some other way, have children more or less prone to nervousness. It matters not what may be the form of inheritance—whether it be of a brain in some way imperfect, or of a deficient blood-supply; it is in any case the inheritance of functionally-modified structures.

Verification of the reasons above given for the paucity of this direct evidence is yielded by contemplation of it, for it is observable that the cases named are cases which, from one or other cause, have thrust themselves on observation. They justify the suspicion that it is not because such cases are rare that many of them cannot be cited, but simply because they are mostly unobtrusive, and to be found only by that deliberate search which nobody makes. I say nobody, but I am wrong. Successful search has been made by one whose competence as an observer is beyond question, and whose testimony is less liable than that of all others to any bias toward the conclusion that such inheritance takes place. I refer to the author of the *Origin of Species.*

Now-a-days most naturalists are more Darwinian than Mr. Darwin himself. I do not mean that their beliefs in organic evolution are more decided; though I shall be supposed to mean this by the mass of readers, who identify Mr. Darwin's great contribution to the theory of organic evolution, with the theory of organic evolution itself, and even with the theory of evolution at large. But I mean that the particular factor which he first recognized as having played so immense a part in organic evolution, has come to be regarded by his followers as the sole factor, though it was not so regarded by him. It is true that he apparently rejected altogether the causal agencies alleged by earlier inquirers. In the Historical Sketch prefixed to the later editions of his *Origin of Species* (p. xiv, note), he writes:—"It is curious how largely my grandfather, Dr. Erasmus Darwin, anticipated the views and erroneous grounds of opinion of Lamarck in his 'Zoonomia' (vol. i, pp. 500–510), published in 1794." And since, among the views thus referred to, was the view that changes of structure in organisms arise by the inheritance of functionally-produced changes, Mr. Darwin seems, by the above sentence, to have implied his disbelief in such inheritance. But he did not mean to imply this; for his belief in it as a cause of evolution, if not an important cause, is proved by many passages in his works. In the first chapter of the *Origin of Species* (p. 11 of the first edition), he says respecting the inherited effects of habit, that "with animals the increased use or disuse of parts has had a marked influence;" and he gives as instances the changed relative weights of the wing bones and leg bones of the wild duck and the domestic duck, "the great and inherited development of the udders in cows and goats," and the drooping ears of various domestic animals. Here are other passages taken from the latest edition of the work.

"I think there can be no doubt that use in our domestic animals has strengthened and enlarged certain parts, and disuse diminished them; and that such modifications are inherited" (p. 108). [And on the following pages he gives five further examples of such effects.] "Habit in producing constitutional peculiarities and use in strengthening and disuse in weakening and diminishing organs, appear in many cases to have been potent in their effects" (p. 131). "When discussing special cases, Mr. Mivart passes over the effects of the increased use and disuse of parts, which I have always maintained to be highly important, and have treated in my 'Variation under Domestication' at greater length than, as I believe, any other writer" (p. 176). "Disuse, on the other hand, will account for the less developed condition of the whole inferior half of the body, including the lateral fins" (p. 188). "I may give another instance of a structure which apparently owes its origin exclusively to use or habit" (p. 188). "It appears probable that disuse has been the main agent in rendering organs rudimentary" (pp. 400–401). "On the whole, we may conclude that habit, or use and disuse, have, in some cases, played a considerable part in the modification of the constitution and structure; but that the effects have often been largely combined with, and sometimes overmastered by, the natural selection of innate variations" (p. 114).

In his subsequent work, *The Variation of Animals and Plants under Domestication*, where he goes into full detail, Mr. Darwin gives more numerous illustrations of the inherited effects of use and disuse. The following are some of the cases, quoted from volume i of the first edition :

Treating of domesticated rabbits, he says:—"the want of exercise has apparently modified the proportional length of the limbs in comparison with the body" (p. 116). "We thus see that the most important and complicated organ [the brain] in the whole organization is subject to the law of decrease in size from disuse" (p. 129). He remarks that in birds of the oceanic islands "not persecuted by any enemies, the reduction of their wings has probably been caused by gradual disuse." After comparing one of these, the water-hen of Tristan d'Acunha, with the European water-hen, and showing that all the bones concerned in flight are smaller, he adds—"Hence in the skeleton of this natural species nearly the same changes have occurred, only carried a little further, as with our domestic ducks, and in this latter case I presume no one will dispute that they have resulted from the lessened use of the wings and the increased use of the legs" (pp. 286–7). "As with other long-domesticated animals, the instincts of the silk-moth have suffered. The caterpillars, when placed on a mulberry-tree, often commit the strange mistake of devouring the base of the leaf on which they are feeding, and consequently fall down; but they are capable, according to M. Robinet, of again crawling up the trunk. Even this capacity sometimes fails, for M. Martins placed some caterpillars on a tree, and those which fell were not able to remount and perished of hunger; they were even incapable of passing from leaf to leaf" (p. 304).

Here are some instances of like meaning from volume ii.

"In many cases there is reason to believe that the lessened use of various organs has affected the corresponding parts in the offspring. But there is no good evidence that this ever follows in the course of a single generation. . . . Our domestic fowls, ducks, and geese have almost lost, not only in the individual but in the race, their power of flight; for we do not see a chicken, when frightened, take flight like a young pheasant. . . . With domestic pigeons, the length of the sternum, the prominence of its crest, the length of the scapulæ and furcula, the length of the wings as measured from tip to tip of the radius, are all reduced relatively to the same parts in the wild pigeon." [After detailing kindred diminutions in fowls and ducks, Mr. Darwin adds] "The decreased weight and size of the bones, in the foregoing cases, is probably the indirect result of the reaction of the weakened muscles on the bones" (pp. 297–8). "Nathusius has shown that, with the improved races of the pig, the shortened legs and snout, the form of the articular condyles of the occiput, and the position of the jaws with the upper canine teeth projecting in a most anomalous manner in front of the lower canines, may be attributed to these parts not having been fully exercised. . . . These modifications of structure, which are all strictly inherited, characterize several improved breeds, so that they cannot have been derived from any single domestic or wild stock. With respect to cattle, Professor Tanner has remarked that the lungs and liver in the improved breeds 'are found to be considerably reduced in size when compared with those possessed by animals having perfect liberty;' . . . The cause of the reduced lungs in highly-bred animals which take little exercise is obvious" (pp. 299–300). [And on pp. 301, 302, and 303, he gives facts showing the effects of use and disuse in changing, among domestic animals, the characters of the ears, the lengths of the intestines, and, in various ways, the natures of the instincts.]

But Mr. Darwin's admission, or rather his assertion, that the inheritance of functionally-produced modifications has been a factor in organic evolution, is made clear not by these passages alone and by kindred ones. It is made clearer still by a passage in the preface to the second edition of his *Descent of Man.* He there protests against that current version of his views in which this factor makes no appearance. The passage is as follows:

"I may take this opportunity of remarking that my critics frequently assume that I attribute all changes of corporeal structure and mental power exclusively to the natural selection of such variations as are often called spontaneous; whereas, even in the first edition of the 'Origin of Species,' I distinctly stated that great weight must be attributed to the inherited effects of use and disuse, with respect both to the body and mind."

Nor is this all. There is evidence that Mr. Darwin's belief in the efficiency of this factor, became stronger as he grew older and accumulated more evidence. The first of the extracts above given, taken from the sixth edition of the *Origin of Species,* runs thus:

"I think there can be no doubt that use in our domestic animals has strengthened and enlarged certain parts, and disuse diminished them; and that such modifications are inherited."

Now on turning to the first edition, p. 134, it will be found that instead of the words—"I think there can be no doubt," the words originally used were—"I think there can be *little* doubt." That this deliberate erasure of a qualifying word and substitution of a word implying unqualified belief, was due to a more decided recognition of a factor originally under-estimated, is clearly implied by the wording of the above-quoted passage from the preface to the *Descent of Man;* where he says that "*even* in the first edition of the 'Origin of Species,'" etc.: the implication being that much more in subsequent editions, and subsequent works, had he insisted on this factor. The change thus indicated is especially significant as having occurred at a time of life when the natural tendency is toward fixity of opinion.

During that earlier period when he was discovering the multitudinous cases in which his own hypothesis afforded solutions, and simultaneously observing how utterly futile in these multitudinous cases was the hypothesis propounded by his grandfather and Lamarck, Mr. Darwin was, not unnaturally, almost betrayed into the belief that the one is all-sufficient and the other inoperative. But in the mind of one so candid and ever open to more evidence, there naturally came a reaction. The inheritance of functionally-produced modifications, which, judging by the passage quoted above concerning the views of these earlier inquirers, would seem to have been at one time denied, but which as we have seen was always to some extent recognized, came to be recognized more and more, and deliberately included as a factor of importance.

Of this reaction displayed in the later writings of Mr. Darwin, let us now ask—Has it not to be carried further? Was the share in organic evolution which Mr. Darwin latterly assigned to the transmission of modifications caused by use and disuse, its due share? Consideration of the groups of evidences given above, will, I think, lead us to believe that its share has been much larger than he supposed even in his later days.

There is first the implication yielded by extensive classes of phenomena which remain inexplicable in the absence of this factor. If, as we see, co-operative parts do not vary together, even when few and close together, and may not therefore be assumed to do so when many and remote, we cannot account for those innumerable changes in organization which are implied when, for advantageous use of some modified part, many other parts which join it in action have to be modified.

Further, as increasing complexity of structure, accompanying increasing complexity of life, implies increasing number of faculties, of which each one conduces to preservation of self or descendants; and as the various individuals of a species, severally requiring something like the normal amounts of all these, may individually profit, here by an unusual amount of one, and there by an unusual amount of another; it follows that as the number of faculties becomes greater, it becomes more difficult for any one to be further developed by natural selection. Only where increase of some one is *predominantly* advantageous does the means seem adequate to the end. Especially in the case of powers which do not subserve self-preservation in appreciable degrees, does development by natural selection appear impracticable.

It is a fact recognized by Mr. Darwin, that where, by selection through successive generations, a part has been increased or decreased, its reaction upon other parts entails changes in them. This reaction is effected through the changes of function involved. If the changes of structure produced by such changes of function, are inheritable, then the re-adjustment of parts throughout the organism, taking place generation after generation, maintains an approximate balance ; but if not, then generation after generation the organism must get more and more out of gear, and tend to become unworkable.

Further, as it is proved that change in the balance of functions registers its effects on the reproductive elements, we have to choose between the alternatives that the registered effects are irrelevant to the particular modifications which the organism has undergone, or that they are such as tend to produce repetitions of these modifications. The last of these alternatives makes the facts comprehensible ; but the first of them not only leaves us with several unsolved problems, but is incongruous with the general truth that by reproduction, ancestral traits, down to minute details, are transmitted.

Though, in the absence of pecuniary interests and the interests in hobbies, no such special experiments as those which have established the inheritance or fortuitous variations have been made to ascertain whether functionally-produced modifications are inherited ; yet certain apparent instances of such inheritance have forced themselves on observation without being sought for. In addition to other indications of a less conspicuous kind, is the one I have given above—the fact that the apparatus for tearing and mastication has decreased with decrease of its function, alike in civilized man and in some varieties of dogs which lead protected and pampered lives. Of the numerous cases named by Mr. Darwin, it is observable that they are yielded not by one class of parts only, but by most if not all classes—by the dermal system, the muscular system, the osseous system, the nervous system, the viscera ; and that among parts liable to be functionally modified, the most numerous observed cases of inheritance are furnished by those which admit of preservation and easy comparison—the bones : these cases, moreover, being specially significant as showing how, in sundry unallied species, parallel changes of structure have occurred along with parallel changes of habit.

What, then, shall we say of the general implication? Are we to stop short with the admission that inheritance of functionally-produced modifications takes place only in cases in which there is evidence of it? May we properly assume that these many instances of changes of structure caused by changes of function, occurring in various tissues and various organs, are merely special and exceptional instances having no general significance? Shall we suppose that though the evidence which already exists has come to light without aid from a body of inquirers, there would be no great increase were due attention devoted to the collection of evidence? This is, I think, not a reasonable supposition. To me the *ensemble* of the facts suggests the belief, scarcely to be resisted, that the inheritance of functionally-produced modifications takes place universally. Looking at physiological phenomena as conforming to physical principles, it is difficult to conceive that a changed play of organic forces which in many cases of different kinds produces an inherited change of structure, does not do this in all cases. The implication, very strong I think, is that the action of every organ produces on it a reaction which, usually not altering its rate of nutrition, sometimes leaves it with diminished nutrition consequent on diminished action, and at other times increases its nutrition in proportion to its increased action; that while generating a modified *consensus* of functions and of structures, the activities are at the same time impressing this modified *consensus* on the sperm-cells and germ-cells whence future individuals are to be produced; and that in ways mostly too small to be identified, but occasionally in more conspicuous ways and in the course of generations, the resulting modifications of one or other kind show themselves. Further, it seems to me that as there are certain extensive classes of phenomena which are inexplicable if we assume the inheritance of fortuitous variations to be the sole factor, but which become at once explicable if we admit the inheritance of functionally-produced changes, we are justified in concluding that this inheritance of functionally-produced changes has been not simply a co-operating factor in organic evolution, but has been a co-operating factor without which organic evolution, in its higher forms at any rate, could never have taken place.

Be this or be it not a warrantable conclusion, there is, I think, good reason for a provisional acceptance of the hypothesis that the effects of use and disuse are inheritable; and for a methodic pursuit of inquiries with the view of either establishing it or disproving it. It seems scarcely reasonable to accept without clear demonstration, the belief that while a trivial difference of structure arising spontaneously is transmissible, a massive difference of structure, maintained generation after generation by change of function, leaves no trace in posterity. Considering that unquestionably the modification of structure by function is a *vera causa*, in so far as concerns the individual; and considering the number of facts which so competent an observer as Mr. Darwin regarded as evidence that transmission of such modifications takes place in particular cases; the hypothesis that such transmission takes place in conformity with a general law, holding of all active structures, should, I think, be regarded as at least a good working hypothesis.

But now supposing the broad conclusion above drawn to be granted—supposing all to agree that from the beginning, along with inheritance of useful variations fortuitously arising, there has been inheritance of effects produced by use and disuse; do there remain no classes of organic phenomena unaccounted for? To this question I think it must be replied that there do remain classes of organic phenomena unaccounted for. It may, I believe, be shown that certain cardinal traits of animals and plants at large are still unexplained; and that a further factor must be recognized. To show this, however, will require another paper.

BOTANY AS A RECREATION FOR INVALIDS.

By Miss E. F. ANDREWS.

IN a recent number of "The Popular Science Monthly," the writer of an interesting article, on "Thomasville as a Winter Resort," mentions the want of public amusements there as a subject of regret from a hygienic point of view. The criticism is a just one, and unfortunately applies to most of our Southern health resorts—St. Augustine, with its yacht club and sea-bathing, and Jacksonville, with a few other cities large enough to attract theatrical companies, forming possible exceptions.

Invalids, as a rule, have a great deal of leisure on their hands—more of it than they like—and to fill this time pleasantly is a question involving a good deal more than mere amusement. The importance of mental distraction to invalids is a fact too universally recognized to call for comment here, my object in this paper being merely to suggest a mode of distraction that, in my own experience, has not only been attended with the happiest results physically, but has proved a source of intense and never-failing pleasure. I allude to the study of botany—not the tiresome, profitless study of text-books, but of the woods, and fields, and meadows.

The beauty of this pursuit is that it takes the student out-of-doors, and throat and lung troubles, as has been truly said, are house-diseases. I am speaking, of course, to those who have begun to fight the enemy before he has captured the inner defenses, and who are supposed to be strong enough to do a reasonable amount of walking, and some solid thinking. For botany, though the simplest of the sciences, can not be mastered without some effort. You are met right at the threshold by that fearful, technical vocabulary which must be conquered before advancing a single step—a labor so formidable and repellent, when undertaken according to the old school-book method, that I do not wonder so many have shrunk away from it in disgust or in despair.

But even this task, apparently as formidable as learning a new tongue, can be made a pastime if rightly undertaken. Don't try to learn definitions or commit long strings of names to memory from a book, but get some simple work and take it out into the woods with you. Don't worry with writing schedules or trying to draw outlines of the different kinds of leaves, but gather as many as you can; then, by reference to the book, describe them to yourself in botanical terms, and keep on in this way till you can give a scientific description of any plant you see, without the book. In a few weeks you will find that you have mastered, almost without knowing it, the dreadful bugbear of botanical language, and got a good deal of solid pleasure out of the process to boot.

You are now ready to take up the classification of plants, and to study their habits and relationships—and this is where the real pleasure begins. Don't worry about species at first, but be satisfied for a time with referring the different plants you meet to their appropriate orders and genera; specific distinctions are often perplexing, and can be attended to later. Gray's "Manual" and Chapman's "Southern Flora" are the only hand-books you will need—the latter for Southern Georgia and Florida, the former for more northern latitudes. I have seen Northern amateurs puzzling over Gray in Florida, and wondering that they could find so few of the plants around them described there, never seeming to realize that a manual of the flora of the Northern States would not answer just as well for an almost tropical region.

Florida is a specially interesting region to the botanist on account of the peculiar forms of plant-life to be found there. I wish I had time to introduce the reader to some of my friends of the forest and jungle, though I dare say he will find it more profitable to seek them out for himself. Botanizing in Florida, however, has this drawback: the pine-lands are so poor that, for the most interesting specimens, you must go to the swamps and hummocks, at the risk of getting more malaria than plants, as I can testify to my cost. But in Southern Georgia there is no such danger. The soil of the pine-lands there is richer, and the whole earth becomes, in spring-time, an Eden of beauty and fragrance. There is no need to go into malarious places; you can hardly set your foot down anywhere without treading on flowers. At a place near the railroad, between Albany and Thomasville, I once stood and gathered seventeen different species without moving out of my tracks. The Houstonias, Atamasco lilies, and jellow jasmines, make their appearance in February, and from then on till June the most diligent collector will have had as much as he can do to keep up with the rich succession of plant-life constantly unfolding itself to view.

And, all the while that one is pursuing a delightful study, he is getting abundant exercise in the open air, without the dreary consciousness of exertion for exertion's sake. One can walk for hours on a botanical ramble without fatigue, when twenty minutes of an aimless "constitutional" would send one home fagged out in body and mind. The parlor gymnastics recommended by Mr. Youmans may have their value in some cases, but for myself the most dismal moments I have ever spent were while laboring conscientiously with dumb-bells and Indian clubs in the name of exercise. Physical exercise, for its own sake, is intense and profitless, and often, I believe, pernicious labor. Give yourself a motive for exertion, and it then becomes exhilarating. The study of plants supplies just such a motive as invalids need. It is too useless (from a practical point of view) to be suggestive of labor, and yet so exceedingly fascinating as to make you ready to undergo any amount of labor in the prosecution of your favorite "fad." I remember once exposing myself to a terrible danger in endeavoring to get possession of a rare and (to me) new plant. I scarcely thought of the risk then, though now the bare recollection of it makes me shudder. This enthusiasm, which the science of botany awakens in all who devote themselves to it, is not its least valuable hygienic factor, for a little genuine enthusiasm will put more life into a sick body than all the drugs in the dispensary.

After all, the proof of the pudding is in the eating, and in conclusion I can only urge fellow-sufferers, who have a moderate amount of strength and patience, to try my simple prescription. As an old negro nurse once said to me anent some "doctor's stuff," "If it don't do you no good, it won't do you no harm," and will at least prove a wholesome diversion from the imbecile fancy-work, and still more imbecile gossip, that make so large a part of the daily routine of life at most resorts of health and pleasure.

THE FRENCH PROBLEM IN CANADA.

By GEORGE H. CLARKE.

THE rapid growth of the French population in the Canadian provinces and the New England States has given rise to much speculation as to the future of the race. Thoughtful men in the Dominion see in its steady increase and aggressive character elements of danger to the stability of the Confederation.

The last census returns show that over one third of the population of Canada is of French origin, while in the New England States there is a large and growing French-Canadian element, wedded to its language, religion, and traditions, and controlled to an extraordinary degree by its astute and admirably organized clergy. Quebec, though a province in a British colony, is as thoroughly French as it was before the conquest. A century and a quarter of British rule has had no effect in Anglicizing the race, or leavening it with the progressive ideas which prevail in all English-speaking communities. As the Canadian French were at the conquest, their descendants remain to this day—a race isolated and apart from all others on the continent, having little in common with their neighbors, or even with their kindred in France. While the great tide of modern progress and civilization is surging everywhere else through the continent, the Province of Quebec is the one stagnant pool which is never rippled by a freshening current, and over which hangs the miasma of mediæval superstition.

The non-progressive character of French civilization on this continent is due partly to the feudal institutions introduced by the early settlers, but mainly to the concessions granted by the victors to the vanquished when Canada became a British colony. By the terms of the treaty with France, and by the Quebec Act passed by the Imperial Parliament on the eve of the struggle with the Thirteen Colonies, the French population of Canada were granted the free exercise of their religion, and were allowed to retain their language, customs, and laws. By the conquest they secured all the privileges of British citizenship, without losing any of their cherished rights and privileges. Through the prodigal liberality of the British Government, the Church of Rome became the established church of Quebec, vested with all the powers which it possessed in France in the days of the "great monarch," to collect tithes and enforce its decrees. The clergy were not slow to avail themselves of those enormous powers for their own aggrandizement, and to strengthen their influence over the people. The policy of the Church from the first, but more especially of late years, has been to isolate its people from their Protestant and English-speaking fellow-citizens. It controls all the public schools and most of the higher educational institutes in the province, and from their childhood it instructs the French Canadians to jealously guard their treaty rights—to preserve their language, their laws, and their institutions. The education of the people in the public schools consists mainly in memorizing the doctrines and dogmas of the Church, and the time which is devoted in the free schools of Ontario to acquiring secular knowledge is spent by the French children in devotional exercises. The masses of the population are kept in ignorance, while the few who can afford to attend the colleges are trained by the Jesuits. Thus the press, the bar, the bench, and the Legislature, are controlled by the pulpit.

Among their public men are some of splendid ability, but with minds narrowed by provincialism and race-prejudices, and warped by religious bigotry. Occasionally one among them ventures to express independent opinions, which subject him to the censure of the bishop of the diocese. If he repents and abandons the error of his ways, he is received back into favor; if he persists in his independence, he may expect, at the very next election, to be relegated to the obscurity of private life. Thus the control of the Church over the French population of the Province of Quebec is complete, and is constantly exercised to prevent their amalgamation with other races on the continent. Intermarriage with Protestants is sternly denounced, and early marriages are earnestly advocated from the pulpit. Their faithful obedience to their pastors in these matters is proved by the census returns.

During the one hundred and fifty years that France held possession of Canada, the population increased but slowly. In 1763, four years after the conquest, it was estimated at about 65,000. Under British rule, in one hundred and twenty-five years it has grown to about 1,500,000 in Canada, and it is estimated that there are nearly half a million of the race in the United States.

The increase of population in the Province of Quebec has, however, been attended with some disadvantage as well as profit to the Church. The system of subdividing and over-cropping farms has impoverished the soil and led to much poverty in the older communities. Adventurous colonists as the early French were, their descendants manifest little inclination to establish settlements in the wilderness. They prefer, when crowded out of their old homes on the banks of the St. Lawrence, to emigrate to the New England States, where they can obtain in the manufacturing establishments employment better suited to their taste and social instinct, and larger remuneration than can be had in their own country. This exodus became so extensive during a period of depression some seven years ago that it excited alarm in the minds of the ecclesiastical and political leaders of the province. The Quebec Legislature, which is practically controlled by the clergy, and the Dominion Parliament, in which they hold the balance of power, voted large sums to repatriate the self-exiled population, but their efforts were attended with anything but gratifying results.

About that time the Province of Manitoba, which had been partly colonized by the French prior to the purchase of the Hudson Bay Territories by the Dominion, was thrown open to settlement by the establishment of railway communication with the Red River Valley. A determined effort was made by the French-Canadian leaders to convert this land of promise into another Quebec, in which the French language, French laws and customs, and the Roman Catholic religion, should prevail. With that end in view, through the influence of Sir George Cartier, Manitoba was originally made a small province, in which the French half-breeds had a large majority. To wean them from their nomadic habits, and to give them an influence altogether disproportionate to their numbers and intelligence, they and their children were granted extensive tracts of land in the Red River Valley, and large inducements were held out to the French Canadians in the United States to locate lands and settle in the neighborhood of their Metis kindred. Some were persuaded to repatriate themselves and assist in carrying out the designs of their leaders, but the vast majority preferred to remain in the manufacturing towns of New England.

From Ontario a steady stream of settlers flowed into Manitoba, and, in a very short time, the hopes of Quebec were blighted. The French element was swamped by the flood from Ontario. The control of the province passed into the hands of the Ontarians, the boundaries of the province were enlarged, and Manitoba, instead of becoming a second Quebec, promises to be a new and greater Ontario.

Balked in their design to capture the great Northwest, the French-Canadian leaders turned their attention to the easier task of "freezing out" the small English-speaking element in Quebec. The population of British origin, outside of Montreal, was principally in the Eastern Townships and in the counties north of the Ottawa River, and formed about one sixth of the whole. The French Canadians were offered inducements to settle on the wild lands in the Eastern Townships. Considerable numbers were in this way led to return to their native land. Wherever an English-speaking farmer was found willing to part with his property, a French-Canadian purchaser was always at hand to secure it. Where English-speaking owners of unpatented lands had failed to comply with any of the numerous conditions of settlement, their lots were confiscated, no refund was made of the purchase-money or compensation allowed for improvements, and they were resold to French Canadians.

This policy, although inaugurated but three or four years before the census of 1881 was taken, had such a marked effect that the returns attracted attention and excited much comment throughout the Dominion. While the entire population of the Province of Quebec had increased slightly, but steadily, during the decade, the English-speaking population had remained almost stationary, and the disproportion between the two races had become more marked. And this had occurred in face of the fact that there had been a large exodus of the French population, not only to the New England States, but also to East Ontario, where they filled up the gaps made by the movement of the Ontario farmers to the Northwest. The English-speaking population are being steadily rooted out, and their places filled by settlers of French origin. Not content with wresting Quebec from the conqueror, the French Canadians are spreading into New Brunswick on the east and Ontario on the west. In the latter province they control two counties already, and will soon have majorities in two others; and it is only a question of time when they will have possession of the capital of the Dominion, a consummation which the French-Canadian members of the Dominion Cabinet are endeavoring to hasten by filling every vacancy in the civil service, so far as they can, with their countrymen.

The rapid increase and aggressiveness of the French-Canadian race, coupled with their determination to hold themselves aloof from the other sections of the population, have led thoughtful men to despair of the future of the Dominion. The hope that the confederation of the provinces would bring about a fusion of the races must have died out of the breasts of the most sanguine who have watched the agitation in Quebec over the Northwest rebellion and the execution of Riel. The French throughout the Dominion have, with few exceptions, made the cause of the rebel half-breeds their own, and exalted their mercenary leader into a national hero and a martyr. Their public men, casting aside all party ties and patriotic considerations, have formed themselves into a provincial party whose object is to avenge the death of the late rebel leader, and to give to Quebec, by their united action, a predominant influence in the Parliament of the Dominion. That their unpatriotic stand will lead to a coalition of the English-speaking majority no one who is aware of the violence of party feeling in Canada will expect, and the only hope, in the opinion of many, of preserving the Dominion from the disaster of French domination lies in the success of the Government party in the next appeal to the country, or in annexation to the United States.

The facts which are above set forth have caused many of the leaders of public opinion in Canada to take a pessimistic view of the future of the Dominion. But there are, on the other side, indications that a brighter destiny awaits the Confederation.

The self-exiled Quebecers in the New England States, though followed to their new homes and carefully advised and guarded by their clergy, come in contact with a population which, bred under republican institutions, has always manifested a manly independence in spiritual as well as in temporal matters. The *habitant* never loses his love for his native land, but residence in the Great Republic brightens his intelligence and gives him a more exalted idea of his importance as an individual, and a sense of independence which is wholly foreign to the character of his countrymen at home. These men revisit their native province from time to time, carrying with them their new and advanced ideas, and thus they are leavening the masses in Quebec. Railways penetrate localities which, until recently, were as isolated from the rest of the continent as if they had been situated in the heart of China. Visitors from the outside world, who know not the *curé* and ignore the clergy generally, find their way into the most remote hamlets, carrying with them new ideas of life. Even the schools, though employed by the clergy more to prevent the spread of knowledge than to impart instruction, by teaching the youth of the country to read, enable them, when the opportunity occurs, to enlighten their minds by tasting the forbidden fruits of literature proscribed by the Church. The growth of public intelligence is necessarily slow, opposed as it is by the most powerful organization the world has ever known, but every year some slight advance is made, and to a corresponding extent the power of the Church is diminished.

When freed from ecclesiastical tyranny, the French race in Quebec possess native ability and qualities which will make them a valuable element in the population of the continent. Their industry, economy, frugality, and docility, their power of imitation, and their disinclination to become citizens of the United States, have led their enemies to brand them as the "Chinese of the East"; but, with those valuable characteristics of the Celestial, they combine others which will place them, when emancipated from the thralldom of the Church, abreast of the most enlightened and progressive nations of the world. When that time comes, they will cease to be regarded as a burden upon the Dominion and a barrier to its progress. They will be recognized as equals, in every sense of the word, of their brethren of British origin, and their rapid increase will be viewed as a benefit rather than a disaster to the Dominion.

It is difficult to understand why the growth of the French-Canadian people should excite misgivings in the minds of the statesmen of Canada. The French race outside of Quebec has increased but slowly. It has never been successful in colonizing. In France itself the growth of the population is exceptionally slow; in the colonies of the republic the progress is even less. While Canada was a colony of France, owing to frequent wars and the exactions of the seigniors and the Church, the population in a century and a half had reached only 65,000; it is only since they have been emancipated from feudal serfdom and enjoyed the blessings of free institutions that they have developed any marked power of reproduction. In one hundred and twenty years under British rule they have increased to nearly 2,000,000, and this rapid increase has been aided little if any by immigration from France. It is due almost entirely to natural increase, and to natural increase it must be restricted in the future.

The growth of the French population on this continent has been rapid, but not phenomenal. It bears no comparison with the extraordinary expansion of the Anglo-Saxon race, even in the Dominion of Canada. Quebec had a population of 100,000, and there was a French colony on the east side of the Detroit River before there were any English-speaking inhabitants in Ontario, where they now number nearly 2,000,000. With all the advantages of a start of a century and a half, the French in Ontario do not exceed 120,000, and in the entire Dominion not over 1,500,000, out of a total of 4,500,000. Until the western movement of the Ontario farmers, some eight years ago, the spread of the French race in Ontario was almost unnoticed. It was confined almost exclusively to laborers employed by lumbering firms in their mills and in the woods, a fluctuating population as little disposed to remain permanently away from their native land as the Chinese on the Pacific coast. While Ontario is rapidly colonizing Manitoba and the vast Northwest Territories, and filling up her waste lands at home, Quebec is making but slow progress in comparison in its work of gallicizing Ontario, and her people prefer expatriation to facing the hardships incidental to pioneer life in the inhospitable wilderness north of the St. Lawrence and the Ottawa. Of the seven provinces of the Dominion, Quebec is the only one in which they possess a controlling influence; in the others, and in the United States, they are merely hewers of wood and drawers of water for the more energetic and intelligent Anglo-Saxon.

While the only fecund branch of the Gallic race is that which inhabits Eastern Canada, the British people at home and abroad have displayed marvelous powers of expansion. Every year populous swarms leave the parent hive, yet they are scarcely missed. Despite the constant drain, the Island races in Europe double every fifty-six years and in the colonies every twenty-five years, whereas the population of France doubles only in one hundred and forty years. The French commenced the work of colonizing America at the same time as the British, yet the latter have expanded to 60,000,000, while the former are represented by a total of 2,000,000. The wonderful development of the Island races continues to follow the British flag in every quarter of the globe. In Australia, New Zealand, South Africa, and other colonies, the increase has been almost as marked as on this continent, and in strong contrast to the sterility of the French at home and in their colonies everywhere.

The capacity of the Island races to absorb foreign elements of population has been illustrated to an extraordinary degree in the United States. The surplus population of every country in Europe pours in a constant stream into the republic, bringing with it customs, languages, and ideas of government wholly different from those which prevail in the United States. Yet, in a short time, this foreign mass is assimilated. The aliens become naturalized citizens; they acquire very soon a knowledge of the prevailing language and the form of government. In a few years they are Americanized, and the second generation speak the language of the continent with the fluency of other natives, and are as thoroughly American citizens as the descendants of the Pilgrim Fathers. In Louisiana a population of French origin have found it to their advantage to adopt the English language and the customs of the people among whom their lot is cast.

There can be little doubt, therefore, that the French Canadians would long since have blended with the dominant race, to their own great benefit and the advantage of the continent, had it not been for the mistaken policy of the British Government over a century ago, and the efforts of the Church of Rome to prevent a consolidation of the people of Canada into one nationality.

In view of these facts there is yet some hope for the future of the Dominion. The diffusion of knowledge among the people, their contact with more enterprising and advanced communities, now rendered practicable by the development of railway communication, and the investigating spirit of the age which priestcraft can not wholly subdue, must sooner or later produce changes which will make of the Canadians a homogeneous population. This is a solution of the problem as desirable as the only other one that has been suggested—a continental union which would crush out at once and forever the aspirations of those who are seeking to establish a new France on the banks of the St. Lawrence.

MR. GLADSTONE AND GENESIS.

By Professor T. H. HUXLEY.

IN controversy, as in courtship, the good old rule to be off with the old before one is on with the new greatly commends itself to my sense of expediency. And, therefore, it appears to me desirable that I should preface such observations as I may have to offer upon the cloud of arguments (the relevancy of which to the issue which I had ventured to raise is not always obvious) put forth by Mr. Gladstone in the January number of this review,* by an endeavor to make clear, to such of our readers as have not had the advantage of a forensic education, the present net result of the discussion.

I am quite aware that, in undertaking this task, I run all the risks to which the man who presumes to deal judicially with his own cause is liable. But it is exactly because I do not shun that risk, but, rather, earnestly desire to be judged by him who cometh after me, provided that he has the knowledge and impartiality appropriate to a judge, that I adopt my present course.

In the article on "The Dawn of Creation and Worship," † it will be remembered that Mr. Gladstone unreservedly commits himself to three propositions. The first is that, according to the writer of the Pentateuch, the "water-population," the "air-population," and the "land-population" of the globe were created successively, in the order named. In the second place, Mr. Gladstone authoritatively asserts that this (as part of his "fourfold order") has been "so affirmed in our time by natural science, that it may be taken as a demonstrated conclusion and established fact." In the third place, Mr. Gladstone argues that the fact of this coincidence of the Pentateuchal story with the results of modern investigation makes it "impossible to avoid the conclusion, first, that either this writer was gifted with faculties passing all human experience, or else his knowledge was divine." And, having settled to his own satisfaction that the first "branch of the alternative is truly nominal and unreal," Mr. Gladstone continues, "So stands the plea for a revelation of truth from God, a plea only to be met by questioning its possibility.

I am a simple-minded person, wholly devoid of subtlety of intellect, so that I willingly admit that there may be depths of alternative meaning in these propositions out of all soundings attainable by my poor plummet. Still, there are a good many people who suffer under a like intellectual limitation; and, for once in my life, I feel that I have the chance of attaining that position of a representative of average opinion, which appears to be the modern ideal of a leader of men,

* "Popular Science Monthly" for March, 1886. † See supplement to present number.

when I make free confession that, after turning the matter over in my mind with all the aid derived from a careful consideration of Mr. Gladstone's reply, I can not get away from my original conviction that, if Mr. Gladstone's second proposition can be shown to be not merely inaccurate, but directly contradictory of facts known to every one who is acquainted with the elements of natural science, the third proposition collapses of itself.

And it was this conviction which led me to enter upon the present discussion. I fancied that if my respected clients, the people of average opinion and capacity, could once be got distinctly to conceive that Mr. Gladstone's views as to the proper method of dealing with grave and difficult scientific and religious problems had permitted him to base a solemn "plea for a revelation of truth from God" upon an error as to a matter of fact, from which the intelligent perusal of a manual of paleontology would have saved him, I need not trouble myself to occupy their time and attention with further comments upon his contribution to apologetic literature. It is for others to judge whether I have efficiently carried out my project or not. It certainly does not count for much that I should be unable to find any flaw in my own case, but I think it counts for a good deal that Mr. Gladstone appears to have been equally unable to do so. He does, indeed, make a great parade of authorities, and I have the greatest respect for those authorities whom Mr. Gladstone mentions. If he will get them to sign a joint memorial to the effect that our present paleontological evidence proves that birds appeared before the "land-population" of terrestrial reptiles, I shall think it my duty to reconsider my position —but not till then.

It will be observed that I have cautiously used the word "appears" in referring to what seems to me to be absence of any real answer to my criticisms in Mr. Gladstone's reply. For I must honestly confess that, notwithstanding long and painful strivings after clear insight, I am still uncertain whether Mr. Gladstone's "Defense" means that the great "plea for a revelation from God" is to be left to perish in the dialectic desert, or whether it is to be withdrawn under the protection of such skirmishers as are available for covering retreat.

In particular the remarkable disquisition which covers pages 624–627 of Mr. Gladstone's last contribution has greatly exercised my mind. Socrates is reported to have said of the works of Heraclitus that he who attempted to comprehend them should be a "Delian swimmer," but that, for his part, what he could understand was so good that he was disposed to believe in the excellence of that which he found unintelligible. In endeavoring to make myself master of Mr. Gladstone's meaning in these pages, I have often been overcome by a feeling analogous to that of Socrates, but not quite the same. That which I do understand, in fact, has appeared to me so very much the reverse of good, that I have sometimes permitted myself to doubt the value of that which I do not understand.

In this part of Mr. Gladstone's reply, in fact, I find nothing of which the bearing upon my arguments is clear to me, except that which relates to the question whether reptiles, so far as they are represented by tortoises and the great majority of lizards and snakes, which are land-animals, are creeping things in the sense of the Pentateuchal writer or not.

I have every respect for the singer of the Song of the Three Children (whoever he may have been); I desire to cast no shadow of doubt upon, but, on the contrary, marvel at, the exactness of Mr. Gladstone's information as to the considerations which "affected the method of the Mosaic writer"; nor do I venture to doubt that the inconvenient intrusion of these contemptible reptiles—"a family fallen from greatness" (p. 627), a miserable decayed aristocracy reduced to mere "skulkers about the earth" (*ibid.*)—in consequence apparently of difficulties about the occupation of land arising out of the earth-hunger of their former serfs, the mammals—into an apologetic argument, which otherwise would run quite smoothly, is in every way to be deprecated. Still, the wretched creatures stand there, importunately demanding notice; and, however different may be the practice in that contentious atmosphere with which Mr. Gladstone expresses and laments his familiarity, in the atmosphere of science it really is of no avail whatever to shut one's eyes to facts, or to try to bury them out of sight under a tumulus of rhetoric. That is my experience of "the Elysian regions of Science," wherein it is a pleasure to me to think that a man of Mr. Gladstone's intimate knowledge of English life during the last quarter of a century believes my philosophic existence to have been rounded off in unbroken equanimity.

However reprehensible, and indeed contemptible, terrestrial reptiles may be, the only question which appears to me to be relevant to my argument is whether these creatures are or are not comprised under the denomination of "everything that creepeth upon the ground."

Mr. Gladstone speaks of the author of the first chapter of Genesis as "the Mosaic writer"; I suppose, therefore, that he will admit that it is equally proper to speak of the author of Leviticus as the "Mosaic writer." Whether such a phrase would be used by any one who had an adequate conception of the assured results of modern Biblical criticism is another matter; but, at any rate, it can not be denied that Leviticus has as much claim to Mosaic authorship as Genesis. Therefore, if one wants to know the sense of a phrase used in Genesis, it will be well to see what Leviticus has to say on the matter. Hence, I commend the following extract from the eleventh chapter of Leviticus to Mr. Gladstone's serious attention:

And these are they which are unclean unto you among the creeping things that creep upon the earth: the weasel, and the mouse, and the great lizard after its kind, and the gecko, and the land-crocodile, and the sand-lizard, and the chameleon. These are they which are unclean to you among all that creep (v. 29–31).

The merest Sunday-school exegesis therefore suffices to prove that when the "Mosaic writer" in Genesis i, 24, speaks of "creeping things" he means to include lizards among them.

This being so, it is agreed on all hands that terrestrial lizards, and other reptiles allied to lizards, occur in the Permian strata. It is further agreed that the Triassic strata were deposited after these. Moreover, it is well known that, even if certain footprints are to be taken as unquestionable evidence of the existence of birds, they are not known to occur in rocks earlier than the Trias, while indubitable remains of birds are to be met with only much later. Hence it follows that natural science does not "affirm" the statement that birds were made on the fifth day, and "everything that creepeth on the ground" on the sixth, on which Mr. Gladstone rests his order; for, as is shown by Leviticus, the "Mosaic writer" includes lizards among his "creeping things."

Perhaps I have given myself superfluous trouble in the preceding argument, for I find that Mr. Gladstone is willing to assume (he does not say to admit) that the statement in the text of Genesis as to reptiles can not "in all points be sustained" (p. 629). But my position is that it can not be sustained in any point, so that, after all, it has perhaps been as well to go over the evidence again. And then Mr. Gladstone proceeds, as if nothing had happened, to tell us that—

There remain great unshaken facts to be weighed. First, the fact that such a record should have been made at all.

As most peoples have their cosmogonies, this "fact" does not strike me as having much value.

Secondly, the fact that, instead of dwelling in generalities, it has placed itself under the severe conditions of a chronological order reaching from the first *nisus* of chaotic matter to the consummated production of a fair and goodly, a furnished and a peopled world.

This "fact" can be regarded as of value only by ignoring the fact demonstrated in my previous paper, that natural science does not confirm the order asserted so far as living things are concerned; and by upsetting a fact to be brought to light presently, to wit, that, in regard to the rest of the Pentateuchal cosmogony, prudent science has very little to say one way or the other.

Thirdly, the fact that its cosmogony seems, in the light of the nineteenth century, to draw more and more of countenance from the best natural philosophy.

I have already questioned the accuracy of this statement, and I do not observe that mere repetition adds to its value.

And, fourthly, that it has described the successive origins of the five great categories of present life with which human experience was and is conversant, in that order which geological authority confirms.

By comparison with a sentence on page 627, in which a fivefold order is substituted for the "fourfold order," on which the "plea for Revelation" was originally founded, it appears that these five categories are "plants, fishes, birds, mammals, and man," which, Mr. Gladstone affirms, "are given to us in Genesis in the order of succession in which they are also given by the latest geological authorities."

I must venture to demur to this statement. I showed, in my previous paper, that there is no reason to doubt that the term "great sea monster" (used in Genesis i, 21) includes the most conspicuous of great sea animals—namely, whales, dolphins, porpoises, manatees, and dugongs;* and, as these are indubitable mammals, it is impossible to affirm that mammals come after birds, which are said to have been created on the same day. Moreover, I pointed out that, as these Cetacea and Sirenia are certainly modified land animals, their existence implies the antecedent existence of land mammals.

Furthermore, I have to remark that the term "fishes," as used technically in zoölogy, by no means covers all the moving creatures that have life, which are bidden to "fill the waters in the seas" (Genesis i, 20–22). Marine mollusks and crustacea, echinoderms, corals, and foraminifera are not technically fishes. But they are abundant in the palæozoic rocks, ages upon ages older than those in which the first evidences of true fishes appear. And, if in a geological book Mr. Gladstone finds the quite true statement that plants appeared before fishes, it is only by a complete misunderstanding that he can be led to imagine it serves his purpose. As a matter of fact, at the present moment, it is a question whether, on the bare evidence afforded by fossils, the marine creeping thing or the marine plant has the seniority. No cautious paleontologist would express a decided opinion on the matter. But, if we are to read the Pentateuchal statement as a scientific document (and, in spite of all protests to the contrary, those who bring it into comparison with science do seek to make a scientific document of it), then, as it is quite clear that only terrestrial plants of high organization are spoken of in verses 11 and 12, no paleontologist would hesitate to say that, at present, the records of sea animal life are vastly older than those of any land-plant describable as "grass, herb yielding seed, or fruit-tree."

Thus, although, in Mr. Gladstone's "Defense," the "old order passeth into new," his case is not improved. The fivefold order is no more "affirmed in our time by natural science" to be "a demonstrated conclusion and established fact" than the fourfold order was. Natural

* Both dolphins and dugongs occur in the Red Sea, porpoises and dolphins in the Mediterranean; so that the "Mosaic writer" may well have been acquainted with them.

science appears to me to decline to have anything to do with either; they are as wrong in detail as they are mistaken in principle.

There is another change of position, the value of which is not so apparent to me as it may well seem to be to those who are unfamiliar with the subject under discussion. Mr. Gladstone discards his three groups of "water population," "air population," and "land population," and substitutes for them (1) fishes, (2) birds, (3) mammals, (4) man. Moreover, it is assumed in a note that "the higher or ordinary mammals" alone were known to the "Mosaic writer" (p. 619). No doubt it looks, at first, as if something were gained by this alteration; for, as I have just pointed out, the word "fishes" can be used in two senses, one of which has a deceptive appearance of adjustability to the "Mosaic" account. Then the inconvenient reptiles are banished out of sight; and, finally, the question of the exact meaning of "higher" and "ordinary" in the case of mammals opens up the prospect of a hopeful logomachy. But what is the good of it all in the face of Leviticus on the one hand and of paleontology on the other?

As, in my apprehension, there is not a shadow of justification for the suggestion that when the Pentateuchal writer says "fowl" he excludes bats (which, as we shall see directly, are expressly included under "fowl" in Leviticus), and as I have already shown that he demonstrably includes reptiles, as well as mammals, among the creeping things of the land, I may be permitted to spare my readers further discussion of the "fivefold order." On the whole, it is seen to be rather more inconsistent with Genesis than its fourfold predecessor.

But I have yet a fresh order to face. Mr. Gladstone (p. 624) understands "the main statements of Genesis, in successive order of time, but without any measurement of its divisions, to be as follows:

1. A period of land, anterior to all life (v. 9 and 10).
2. A period of vegetable life, anterior to animal life (v. 11 and 12).
3. A period of animal life, in the order of fishes (v. 20).
4. Another stage of animal life, in the order of birds.
5. Another, in the order of beasts (v. 24 and 25).
6. Last of all, man (v. 26 and 27)."

Mr. Gladstone then tries to find the proof of the occurrence of a similar succession in sundry excellent works on geology.

I am really grieved to be obliged to say that this third (or is it fourth?) modification of the foundation of the "plea for Revelation" originally set forth satisfies me as little as any of its predecessors.

For, in the first place, I can not accept the assertion that this order is to be found in Genesis. With respect to No. 3, for example, I hold, as I have already said, that "great sea monsters" includes the Cetacea, in which case mammals (which is what, I suppose, Mr. Gladstone means by "beasts") come in under head No. 3, and not under No. 5.

Again, "fowl" are said in Genesis to be created on the same day as fishes; therefore I can not accept an order which makes birds succeed fishes. Once more, as it is quite certain that the term "fowl" includes the bats—for in Leviticus xi, 13–19, we read, "And these shall ye have in abomination among the fowls . . . the heron after its kind, and the hoopoe, and the bat"—it is obvious that bats are also said to have been created at stage No. 3. And as bats are mammals, and their existence obviously presupposes that of terrestrial "beasts," it is quite clear that the latter could not have first appeared as No. 5. I need not repeat my reasons for doubting whether man came "last of all."

As the latter half of Mr. Gladstone's sixfold order thus shows itself to be wholly unauthorized by, and inconsistent with, the plain language of the Pentateuch, I might decline to discuss the admissibility of its former half.

But I will add one or two remarks on this point also. Does Mr. Gladstone mean to say that in any of the works he has cited, or indeed anywhere else, he can find scientific warranty for the assertion that there was a period of land—by which I suppose he means dry land (for submerged land must needs be as old as the separate existence of the sea)—"anterior to all life"?

It may be so, or it may not be so; but where is the evidence which would justify any one in making a positive assertion on the subject? What competent paleontologist will affirm, at this present moment, that he knows anything about the period at which life originated, or will assert more than the extreme probability that such origin was a long way antecedent to any traces of life at present known? What physical geologist will affirm that he knows when dry land began to exist, or will say more than that it was probably very much earlier than any extant direct evidence of terrestrial conditions indicates?

I think I know pretty well the answers which the authorities quoted by Mr. Gladstone would give to these questions; but I leave it to them to give them if they think fit.

If I ventured to speculate on the matter at all, I should say it is by no means certain that sea is older than dry land, inasmuch as a solid terrestrial surface may very well have existed before the earth was cool enough to allow of the existence of fluid water. And in this case dry land may have existed before the sea. As to the first appearance of life, the whole argument of analogy, whatever it may be worth in such a case, is in favor of the absence of living beings until long after the hot-water seas had constituted themselves; and of the subsequent appearance of aquatic before terrestrial forms of life. But whether these "protoplasts" would, if we could examine them, be reckoned among the lowest microscopic algæ, or fungi, or among those doubtful organisms which lie in the debatable land between animals and plants, is, in my judgment, a question on which a prudent biologist will reserve his opinion.

I think that I have now disposed of those parts of Mr. Gladstone's defense in which I seem to discover a design to rescue his solemn "plea for Revelation." But a great deal of the "Proem to Genesis" remains which I would gladly pass over in silence, were such a course consistent with the respect due to so distinguished a champion of the "reconcilers."

I hope that my clients—the people of average opinions—have by this time some confidence in me; for, when I tell them that, after all, Mr. Gladstone is of opinion that the "Mosiac record" was meant to give moral and not scientific instruction to those for whom it was written, they may be disposed to think that I must be misleading them. But let them listen further to what Mr. Gladstone says in a compendious but not exactly correct statement respecting my opinions:

> He holds the writer responsible for scientific precision: I look for nothing of the kind, but assign to him a statement general, which admits exceptions; popular, which aims mainly at producing moral impression; summary, which can not but be open to more or less of criticism of detail. He thinks it is a lecture. I think it is a sermon (p. 618).

I note, incidentally, that Mr. Gladstone appears to consider that the *differentia* between a lecture and a sermon is, that the former, so far as it deals with matters of fact, may be taken seriously, as meaning exactly what it says, while a sermon may not. I have quite enough on my hands without taking up the cudgels for the clergy, who will probably find Mr. Gladstone's definition unflattering.

But I am diverging from my proper business, which is to say that I have given no ground for the ascription of these opinions, and that, as a matter of fact, I do not hold them and never have held them. It is Mr. Gladstone, and not I, who will have it that the Pentateuchal cosmogony is to be taken as science.

My belief, on the contrary, is, and long has been, that the Pentateuchal story of the creation is simply a myth. I suppose it to be an hypothesis respecting the origin of the universe which some ancient thinker found himself able to reconcile with his knowledge, or what he thought was knowledge, of the nature of things, and therefore assumed to be true. As such, I hold it to be not merely an interesting but a venerable monument of a stage in the mental progress of mankind, and I find it difficult to suppose that any one who is acquainted with the cosmogonies of other nations—and especially with those of the Egyptians and the Babylonians, with whom the Israelites were in such frequent and intimate communication—should consider it to possess either more or less scientific importance than may be allotted to these.

Mr. Gladstone's definition of a sermon permits me to suspect that he may not see much difference between that form of discourse and what I call a myth; and I hope it may be something more than the slowness of apprehension, to which I have confessed, which leads me to imagine that a statement which is "general" but "admits exceptions," which is "popular" and "aims mainly at producing moral impression," "summary" and therefore open to "criticism of detail," amounts to a myth, or perhaps less than a myth. Put algebraically, it comes to this, $x = a + b + c$; always remembering that there is nothing to show the exact value of either a, or b, or c. It is true that a is commonly supposed to equal 10, but there are exceptions, and these may reduce it to 8, or 3, or 0; b also popularly means 10, but, being chiefly used by the algebraist as a "moral" value, you can not do much with it in the addition or subtraction of mathematical values; c also is quite "summary," and, if you go into the details of which it is made up, many of them may be wrong, and their sum total equal to 0, or even to a minus quantity.

Mr. Gladstone appears to wish that I should (1) enter upon a sort of essay competition with the author of the Pentateuchal cosmogony; (2) that I should make a further statement about some elementary facts in the history of Indian and Greek philosophy; and (3) that I should show cause for my hesitation in accepting the assertion that Genesis is supported, at any rate to the extent of the first two verses, by the nebular hypothesis.

A certain sense of humor prevents me from accepting the first invitation. I would as soon attempt to put Hamlet's soliloquy into a more scientific shape. But, if I suppose the "Mosaic writer" to be inspired, as Mr. Gladstone does, it would not be consistent with my notions of respect for the Supreme Being to imagine Him unable to frame a form of words which should accurately, or at least not inaccurately, express His own meaning. It is sometimes said that, had the statements contained in the first chapter of Genesis been scientifically true, they would have been unintelligible to ignorant people; but how is the matter mended if, being scientifically untrue, they must needs be rejected by instructed people?

With respect to the second suggestion, it would be presumptuous in me to pretend to instruct Mr. Gladstone in matters which lie as much within the province of Literature and History as in that of Science; but, if any one desirous of further knowledge will be so good as to turn to that most excellent and by no means recondite source of information, the "Encyclopædia Britannica," he will find, under the letter E, the word "Evolution," and a long article on that subject. Now, I do not recommend him to read the first half of the article; but the second half, by my friend Mr. Sully, is really very good. He will there find it said that, in some of the philosophies of ancient India, the idea of evolution is clearly expressed: "Brahma is conceived as the eternal self-existent being, which, on its material side, unfolds itself to the world by gradually condensing itself to material objects through the gradations of ether, fire, water, earth, and other elements." And again: "In the later system of emanation of Sankhya there is a more marked approach to a materialistic doctrine of evolution." What little knowledge I have of the matter—chiefly derived from that very instructive book "Die Religion des Buddha," by C. F. Koeppen, supplemented by Hardy's interesting works—leads me to think that Mr. Sully might have spoken much more strongly as to the evolutionary character of Indian philosophy, and especially of that of the Buddhists. But the question is too large to be dealt with incidentally.

And with respect to early Greek philosophy * the seeker after additional enlightenment need go no further than the same excellent storehouse of information :

> The early Ionian physicists, including Thales, Anaximander, and Anaximenes, seek to explain the world as generated out of a primordial matter which is at the same time the universal support of things. This substance is endowed with a generative or transmutative force by virtue of which it passes into a succession of forms. They thus resemble modern evolutionists, since they regard the world, with its infinite variety of forms, as issuing from a simple mode of matter.

Further on, Mr. Sully remarks that "Heraclitus deserves a prominent place in the history of the idea of evolution," and he states, with perfect justice, that Heraclitus has foreshadowed some of the special peculiarities of Mr. Darwin's views. It is indeed a very strange circumstance that the philosophy of the great Ephesian more than adumbrates the two doctrines which have played leading parts, the one in the development of Christian dogma, the other in that of natural science. The former is the conception of the Word (λόγος) which took its Jewish shape in Alexandria, and its Christian form † in that Gospel which is usually referred to an Ephesian source of some five centuries later date ; and the latter is that of the struggle for existence. The saying that "strife is father and king of all" (πόλεμος πάντων μὲν πατήρ ἐστι, πάντων δὲ βασιλεύς), ascribed to Heraclitus, would be a not inappropriate motto for the "Origin of Species."

I have referred only to Mr. Sully's article, because his authority is quite sufficient for my purpose. But the consultation of any of the more elaborate histories of Greek philosophy, such as the great work of Zeller, for example, will only bring out the same fact into still more striking prominence. I have professed no "minute acquaintance" with either Indian or Greek philosophy, but I have taken a great deal of pains to secure that such knowledge as I do possess shall be accurate and trustworthy.

In the third place, Mr. Gladstone appears to wish that I should discuss with him the question whether the nebular hypothesis is or is not confirmatory of the Pentateuchal account of the origin of things. Mr. Gladstone appears to be prepared to enter upon this campaign

* I said nothing about "the greater number of schools of Greek philosophy," as Mr. Gladstone implies that I did, but expressly spoke of the "founders of Greek philosophy."

† See Heinze, "Die Lehre vom Logos," p. 9, *et seq.*

with a light heart. I confess I am not, and my reason for this backwardness will doubtless surprise Mr. Gladstone. It is that, rather more than a quarter of a century ago (namely, in February, 1859), when it was my duty, as President of the Geological Society, to deliver the Anniversary Address,* I chose a topic which involved a very careful study of the remarkable cosmogonical speculation originally promulgated by Immanuel Kant, and subsequently by Laplace, which is now known as the nebular hypothesis. With the help of such little acquaintance with the principles of physics and astronomy as I had gained, I endeavored to obtain a clear understanding of this speculation in all its bearings. I am not sure that I succeeded; but of this I am certain, that the problems involved are very difficult, even for those who possess the intellectual discipline requisite for dealing with them. And it was this conviction that led me to express my desire to leave the discussion of the question of the asserted harmony between Genesis and the nebular hypothesis to experts in the appropriate branches of knowledge. And I think my course was a wise one; but, as Mr. Gladstone evidently does not understand how there can be any hesitation on my part, unless it arises from a conviction that he is in the right, I may go so far as to set out my difficulties.

They are of two kinds—exegetical and scientific. It appears to me that it is vain to discuss a supposed coincidence between Genesis and science, unless we have first settled, on the one hand, what Genesis says, and, on the other hand, what science says.

In the first place, I can not find any consensus among Biblical scholars as to the meaning of the words "In the beginning God created the heaven and the earth." Some say that the Hebrew word *bara*, which is translated "create," means "made out of nothing." I venture to object to that rendering, not on the ground of scholarship, but of common sense. Omnipotence itself can surely no more make something "out of" nothing than it can make a triangular circle. What is intended by "made out of nothing" appears to be "caused to come into existence," with the implication that nothing of the same kind previously existed. It is further usually assumed that "the heaven and the earth" means the material substance of the universe. Hence the "Mosaic writer" is taken to imply that, where nothing of a material nature previously existed, this substance appeared. That is perfectly conceivable, and therefore no one can deny that it may have happened. But there are other very authoritative critics who say that the ancient Israelite † who wrote the passage was not likely to have been capable of such abstract thinking, and that, as a matter of philology, *bara* is commonly used to signify the "fashioning," or

* Reprinted in "Lay Sermons, Addresses, and Reviews," 1870.

† "Ancient," doubtless, but his antiquity must not be exaggerated. For example, there is no proof that the "Mosaic" cosmogony was known to the Israelites of Solomon's time.

"forming," of that which already exists. Now, it appears to me that the scientific investigator is wholly incompetent to say anything at all about the first origin of the material universe. The whole power of his organon vanishes when he has to step beyond the chain of natural causes and effects. No form of the nebular hypothesis that I know of is necessarily connected with any view of the origination of the nebular substance. Kant's form of it expressly supposes that the nebular material from which one stellar system starts may be nothing but the disintegrated substance of a stellar and planetary system which has just come to an end. Therefore, so far as I can see, one who believes that matter has existed from all eternity has just as much right to hold the nebular hypothesis as one who believes that matter came into existence at a specified epoch. In other words, the nebular hypothesis and the creation hypothesis, up to this point, neither confirm nor oppose one another.

Next, we read in the revisers' version, in which I suppose the ultimate results of critical scholarship to be embodied: "And the earth was waste [without form, in the authorized version] and void." Most people seem to think that this phraseology intends to imply that the matter out of which the world was to be formed was a veritable "chaos" devoid of law and order. If this interpretation is correct, the nebular hypothesis can have nothing to say to it. The scientific thinker can not admit the absence of law and order, anywhere or any when, in nature. Sometimes law and order are patent and visible to our limited vision; sometimes they are hidden. But every particle of the matter of the most fantastic-looking nebula in the heavens is a realm of law and order in itself, and that it is so is the essential condition of the possibility of solar and planetary evolution from the apparent chaos.*

"Waste" is too vague a term to be worth consideration. "Without form," intelligible enough as a metaphor, if taken literally, is absurd; for a material thing existing in space must have a superficies, and if it has a superficies it has a form. The wildest streaks of mare's-tail clouds in the sky, or the most irregular heavenly nebulæ, have surely just as much form as a geometrical tetrahedron; and as for "void," how can that be void which is full of matter? As poetry, these lines are vivid and admirable; as a scientific statement, which they must be taken to be if any one is justified in comparing them with another scientific statement, they fail to convey any intelligible conception to my mind.

The account proceeds: "And darkness was upon the face of the deep." So be it; but where, then, is the likeness to the celestial nebulæ, of the existence of which we should know nothing unless

* When Jeremiah (iv, 23) says, "I beheld the earth, and, lo, it was waste and void," he certainly does not mean to imply that the form of the earth was less definite, or its substance less solid, than before.

they shone with a light of their own? "And the spirit of God moved upon the face of the waters." I have met with no form of the nebular hypothesis which involves anything analogous to this process.

I have said enough to explain some of the difficulties which arise in my mind when I try to ascertain whether there is any foundation for the contention that the statements contained in the first two verses of Genesis are supported by the nebular hypothesis. The result does not appear to me to be exactly favorable to that contention. The nebular hypothesis assumes the existence of matter having definite properties as its foundation. Whether such matter was created a few thousand years ago, or whether it has existed through an eternal series of metamorphoses of which our present universe is only the last stage, are alternatives, neither of which is scientifically untenable, and neither scientifically demonstrable. But science knows nothing of any stage in which the universe could be said, in other than a metaphorical and popular sense, to be formless or empty, or in any respect less the seat of law and order than it is now. One might as well talk of a fresh laid hen's egg being "without form and void," because the chick therein is potential and not actual, as apply such terms to the nebulous mass which contains a potential solar system.

Until some further enlightenment comes to me, then, I confess myself wholly unable to understand the way in which the nebular hypothesis is to be converted into an ally of the "Mosaic writer."*

But Mr. Gladstone informs us that Professor Dana and Professor Guyot are prepared to prove that the "first or cosmogonical portion of the Proem not only accords with but teaches the nebular hypothesis." †

* In looking through the delightful volume recently published by the Astronomer Royal for Ireland, a day or two ago, I find the following remarks on the nebular hypothesis, which I should have been glad to quote in my text if I had known them sooner:

"Nor can it be ever more than a speculation; it can not be established by observation, nor can it be proved by calculation. It is merely a conjecture, more or less plausible, but perhaps, in some degree, necessarily true, if our present laws of heat, as we understand them, admit of the extreme application here required, and if the present order of things has reigned for sufficient time without the intervention of any influence at present known to us."—"The Story of the Heavens," p. 506.

Would any prudent advocate base a plea, either for or against revelation, upon the coincidence, or want of coincidence, of the declarations of the latter with the requirements of an hypothesis thus guardedly dealt with by an astronomical expert?

† *Postscript to article on "Proem to Genesis" (published in "Popular Science Monthly" for March, 1886).*—I learn with satisfaction that in America, where the stores of geological knowledge have been so greatly enlarged, the business of the reconciler has been taken into the hands of scientists: Dr. Dana, Professor of Geology in Yale College, and Dr. Arnold Guyot, Professor of Geology and Physical Geography in New Jersey College. Both of these authorities, it appears, have adhered through a long career, and now adhere with increased confidence, to the idea of a substantial harmony between science and the Mosaic text. Professor Dana's latest tract has recently appeared in the "Bibliotheca Sacra" for April, 1885. He thinks the evidence doubtful as to the priority of birds over the low or marsupian mammals (p. 214); but strong for an abundant early

There is no one to whose authority on geological questions I am more readily disposed to bow, than that of my eminent friend Professor Dana. But I am familiar with what he has previously said on this topic in his well-known and standard work, into which, strangely enough, it does not seem to have occurred to Mr. Gladstone to look before he set out upon his present undertaking; and unless Professor Dana's latest contribution (which I have not yet met with) takes up altogether new ground, I am afraid I shall not be able to extricate myself, by its help, from my present difficulties.

It is a very long time since I began to think about the relations between modern scientifically ascertained truths and the cosmogonical speculations of the writer of Genesis; and, as I think that Mr. Gladstone might have been able to put his case with a good deal more force if he had thought it worth while to consult the last chapter of Professor Dana's admirable "Manual of Geology," so I think he might have been made aware that he was undertaking an enterprise of which he had not counted the cost, if he had chanced upon a discussion of the subject which I published in 1877.*

Finally, I should like to draw the attention of those who take interest in these topics to the weighty words of one of the most learned and moderate of Biblical critics:

À propos de cette première page de la Bible, on a coutume de nos jours de disserter, à perte de vue, sur l'accord du récit mosaïque avec les sciences naturelles; et comme celles-ci, tout éloignées qu'elles sont encore de la perfection absolue, ont rendu populaires et en quelque sorte irréfragables un certain nombre de faits généraux ou de thèses fondamentales de la cosmologie et de la géologie, c'est le texte sacré qu'on s'évertue à torturer pour le faire concorder avec ces données.†

Trans.—[Pertinently to this first page of the Bible, it has been customary in our days to descant to an extreme on the accord of the Mosaic recital with the

plant life in the Azoic period (p. 213): and he holds, with Professor Guyot, that the first, or cosmogonical, portion of the "Proem" not only accords with, but teaches, the nebular hypothesis (p. 220).

It is a relief to find that the burden of this argument is shared with witnesses, who are competent and unsuspected on the scientific side; and who will not be liable to a repetition *mutatis mutandis* of an old objection: "*This people, which knoweth not the law, is accursed*" (St. John, vii, 49).

Mr. Marsh, Professor of Palæontology in Yale College, holds ("Ornithodontes," 1880, p. 137), on the grounds of the wide differences between the *Archæopteryx* and the other types of early birds, that the common ancestor was remote and probably Palæozoic. He also adheres to the order—1. Reptiles; 2. Birds; 3. Mammals. (It may be well to refer to Sir C. Lyell, "Principles of Geology," vol. iii, p. 175, on the reasons why bird-remains are sometimes rare.)

In my passages referring to geological results, I would ask the reader to substitute *priority* for *succession*. The latter implies a continuity of series, which is not found in the scientific record, since it is broken by the absence of reference to the invertebrates of the palæozoic, and the reptiles of the mesozoic rocks.—*W. E. G.*

* Lectures on Evolution delivered in New York. (American Addresses.)

† Reuss, "L'Histoire Sainte et la Loi," i, 275.

natural sciences; and as the latter, very far removed from absolute perfection as they still are, have rendered popular, and after a manner indisputable, a certain number of general facts or fundamental theses of cosmology and geology, it is the sacred text that they strive to torture in order to make it agree with these data.]

In my paper on the "Interpreters of Nature and the Interpreters of Genesis," while freely availing myself of the rights of a scientific critic, I endeavored to keep the expression of my views well within those bounds of courtesy which are set by self-respect and consideration for others. I am therefore glad to be favored with Mr. Gladstone's acknowledgment of the success of my efforts. I only wish that I could accept all the products of Mr. Gladstone's gracious appreciation, but there is one about which, as a matter of honesty, I hesitate. In fact, if I had expressed my meaning better than I seem to have done, I doubt if this particular proffer of Mr. Gladstone's thanks would have been made.

To my mind, whatever doctrine professes to be the result of the application of the accepted rules of inductive and deductive logic to its subject-matter, and accepts, within the limits which it sets to itself, the supremacy of reason, is science. Whether the subject-matter consists of realities or unrealities, truths or falsehoods, is quite another question. I conceive that ordinary geometry is science, by reason of its method, and I also believe that its axioms, definitions, and conclusions are all true. However, there is a geometry of four dimensions, which I also believe to be science, because its method professes to be strictly scientific. It is true that I can not conceive four dimensions in space, and therefore, for me, the whole affair is unreal. But I have known men of great intellectual powers who seemed to have no difficulty either in conceiving them, or, at any rate, in imagining how they could conceive them, and therefore four-dimensioned geometry comes under my notion of science. So I think astrology is a science, in so far as it professes to reason logically from principles established by just inductive methods. To prevent misunderstanding, perhaps I had better add that I do not believe one whit in astrology; but no more do I believe in Ptolemaic astronomy, or in the catastrophic geology of my youth, although these, in their day, claimed—and, to my mind, rightly claimed—the name of science. If nothing is to be called science but that which is exactly true from beginning to end, I am afraid there is very little science in the world outside mathematics. Among the physical sciences I do not know that any could claim more than that each is true within certain limits, so narrow that, for the present at any rate, they may be neglected. If such is the case, I do not see where the line is to be drawn between exactly true, partially true, and mainly untrue forms of science. And what I have said about the current theology at the end of my paper, leaves, I think, no doubt as to the category in which I rank it. For all that, I think it would be not only unjust, but almost impertinent, to refuse the name of science to the "Summa" of St. Thomas or to the "Institutes" of Calvin.

In conclusion, I confess that my supposed "unjaded appetite" for the sort of controversy in which it needed not Mr. Gladstone's express declaration to tell us he is far better practiced than I am (though probably, without another express declaration, no one would have suspected that his controversial fires are burning low) is already satiated.

In "Elysium" we conduct scientific discussions in a different medium, and we are liable to threatenings of asphyxia in that "atmosphere of contention" in which Mr. Gladstone has been able to live, alert and vigorous beyond the common race of men, as if it were purest mountain air. I trust that he may long continue to seek truth, under the difficult conditions he has chosen for the search, with unabated energy—I had almost said fire :

> "May age not wither him, nor custom stale
> His infinite variety."

But Elysium suits my less robust constitution better, and I beg leave to retire thither, not sorry for my experience of the other region—no one should regret experience—but determined not to repeat it, at any rate, in reference to the "plea for Revelation."—*Nineteenth Century.*

COMMENTS BY PROFESSOR HENRY DRUMMOND.

SCIENCE, Religion, Philology, and History have now unsheathed their most richly chased blades in this famous tournament. So goodly a fight has not been seen for many a day ; and whether one regards the dignity of the combatants, or the gravity and delicacy of the cause, it is not possible to await the issue without the keenest interest. Meanwhile, a voice may be permitted on behalf of a group among the spectators who have not yet been heard in this controversy, but whose modest reluctance to interfere seems only equaled by their right. In arenas more obscure, but not less worthy, they too have fought this fight ; and as a humble camp-follower, and from conviction that the thing must now be done, rather than as one possessing the right to do it, I would venture to state the case on their account.

Mr. Huxley interposes in this question because he is moved by the violence being done in high places to natural science. This third party is constrained to speak because of a similar violence done to theological science. Were the reconcilers of Geology and Genesis equal in insight to their last and most distinguished champion, and did Mr. Gladstone himself realize the full meaning of his own concessions, little further contribution to this controversy might perhaps be called for. And, were the opponents of this ancient fraternity as calm in spirit, as respectful to beliefs, and as discriminating as to the real question at issue as Mr. Huxley, no other word need be spoken. But with a phalanx of reconcilers on the one hand, who will continue to shelter untenable positions under the carefully qualified argument of Mr. Gladstone, and with quasi-scientific men on the other, who will exaggerate and misinterpret the triumph of Mr. Huxley, a further clearing of the ground is necessary. The breadth of view, the sagacity, and inimitable charity of Mr. Gladstone's second article certainly go far with many minds to remove the forebodings with which they received the first. Nevertheless, so powerful a championship of a position which many earnest students of modern religious questions have seen reason wholly to abandon can not but excite misgivings of a serious kind. And though these are now in part removed by the large concessions and ampler statement of the second paper, Mr. Gladstone still deliberately involves himself with the fortunes of the reconcilers. So far, however, is he in advance of most of them that much that may be reluctantly said here against the stand-point from which they work in no sense applies to him. This much fairness not less than courtesy makes it a pleasure to premise.

It will be recognized by every one that the true parties in this case are, as the title of Mr. Huxley's article suggests, "The Interpreters of Genesis and the Interpreters of Nature." Now, who are the interpreters of Genesis? We answer by asking, Who are the interpreters of Nature?

We respectfully point out to Mr. Huxley that his paper contains no single reference to the interpreters of Genesis in the sense in which he uses the term "the interpreters" in the case of science. Who are "the interpreters" of Nature? Mr. Huxley answers, and rightly, himself. And who are "the interpreters" of Genesis? Certainly Mr. Gladstone would be the last to claim this for himself. Does not the legitimate question lie between *modern theology* and modern science? And in perfect fairness should not the title of Mr. Huxley's paper have read, "*Some* interpreters of Genesis, and the scientific interpreters of Nature"? This may be a verbal matter, and we do not press it. But in view of the fact that many will see in Mr. Huxley's article, and in spite of all protestation, a direct and damaging assault upon the Biblical records, would it not have been right to point out the real terms of the antithesis? It may be replied, and justly, that Mr. Huxley is not responsible for the inferences of the uneducated. And in ordinary circumstances it would be gratuitous to define so carefully the real limitations of the question at issue. But the circumstances here are quite exceptional. For, although the widely general knowledge of science makes the aberrations of individual theorists in that department harmless, it is not so in the case of theology. Theology, in this relation, has long suffered under quite unusual treatment. Any visionary is taken, and that notoriously by men of science, as the representative of the system. And it is time for theology to be relieved of the irresponsible favors of a hundred sciolists, whose guerrilla warfare has so long alienated thinking men in all departments of knowledge. That there is a "science of theology" Mr. Huxley himself admits. It has exponents in Britain and Germany as well-equipped in learning, in sobriety, in balance of mind, and in the possession of the scientific spirit, as the best of the interpreters of Nature. When these men speak of science, it is with respectful reliance upon the best and most recent authorities. They complain that when science speaks of them it accepts positions and statements from any quarter, from books which have been for years or centuries outgrown; or from popular teachers whom scientific theology unweariedly repudiates. To theological science the whole underlying theory of the reconcilers is as exploded as Bathybius. And Mr. Huxley's interference, however much they welcome it in the interest of popular theology, is to them the amusing performance of a layman, the value of which to scientific theology is about the same as would be a refutation of the Ptolemaic astronomy to modern physics.*

This, however, to some minds may have to be made plain, and we may briefly devote ourselves to a statement of the case.

The progress of opinion on this whole subject is marked by three phases: First, until the present century the first chapter of Genesis was accepted as a veritable cosmogony. This, in the circumstances, was inevitable. The hypothesis of Laplace was not yet in the field; paleontology, Fracastoro notwithstanding, had produced nothing except what every one knew was the remains of the Noachian Deluge;

* Of course, in commentaries written by experts for popular uses, the condemnatory evidence from natural science is sometimes formally cited in stating the case against the reconcilers generally. From one of the most recent, as well as most able, of these we quote the following passage, in which Mr. Huxley is anticipated in so many words. It is here seen, not only that theology "knew all this before," but how completely it has abandoned the position against which Mr. Huxley's counter-statements are directed: "This narrative is not careful to follow the actual order in which life appeared on the globe: it affirms, e. g., that fruit-trees existed before the sun was made; science can tell us of no such vegetation. It tells us that the birds were created in the fifth day, the reptiles in the sixth; Nature herself tells a different tale, and assures us that creeping things appeared before the flying fowl. But the most convincing proof of the regardlessness of scientific accuracy shown by this writer is found in the fact that in the second chapter he gives a different account from that which he has given in the first, and an account irreconcilable with physical facts. . . . He represents the creation of man as preceding the creation of the lower animals—an order which both the first chapter and physical science assure us was not the actual order observed. . . . It seems to me, therefore, a mistaken and dangerous attempt which is often made to reconcile the account of physical facts given here with that given in Nature herself. These accounts disagree in the date or distance from the present time to which the work of creation is assigned, in the length of time which the preparation of the world for man is said to have occupied, and in the order in which life is introduced into the world."—"Genesis," by Marcus Dods, D. D. Edinburgh, T. & T. Clark, 1882.

and geology, even with Buffon behind it, had so little to say for itself that a hint from the Sorbonne was sufficient to quench what feeble light it had. The genesis of the world, therefore, was left to Moses, and the most mechanical theory of creation—a purely anthropomorphic thing and not really in the sacred page at all—was everywhere accepted.

Presently, as the sciences gathered volume and focused their rays on the past, a new version of creation was spelled out from earth and sea and stars. Accepted at first tentatively, even by men of science, it is not to be wondered at that theologians were for a time unwilling to give up the reading which had held the ground so long. They therefore adopted the policy which is always followed in similar circumstances—compromise and adjustment. Thus intervened the interregnum of the reconcilers, De Luc, Kurtz, Pye-Smith, Hugh Miller, Chalmers, and a hundred others whom we need not name. The man who speaks of the labors of these workers without respect has no acquaintance with the methods by which truth, or error, is ascertained. It was necessary that that mine should be worked, and worked out. Whatever fundamental error underlay it, it was done with reverence, with courage, often with learning and with eloquence. A whole literature sprang up around the reconstruction, and one good end was at least secured—science was ardently studied by the Church. But the failure of the new method was a foregone conclusion, and those who sailed on this shallow sea one by one ran aground. This was a moment of peril—one of those moments which always come when truth is in the making, and which, honestly accepted, lead to new departures in the direction where the true light is ultimately found. The wise among the harmonists accepted the situation, though some of them did not know where next to turn. But deliverance swiftly came, and from an unlooked-for quarter.

For meantime in Germany and England, in a wholly different department of theology, another science was at work. Apart from any questions of doctrinal detail, the young science of Biblical Criticism was beginning to inquire into the composition, meaning, method, and aims of the sacred books. It dealt with these books, in the first instance, simply as literature. Questions of age, authorship, and literary form were for the first time investigated by qualified experts. And the result of these labors—labors in the truest sense scientific—is that these sacred writings are now regarded by theology from a wholly changed stand-point. Now from this stand-point the problem of the reconciliation of Genesis with geology simply disappears. The probable scientific solution, the possibility or impossibility of a harmony—the very statement becomes an absurdity. The question, in fact, is as irrelevant as that of the senior wrangler who asked what Milton's "Paradise Lost" was meant to prove. This is of course the true method of dealing with old theories. Beaten in argument, they will surely rise again; outgrown, they are forever dead. And this is the hall-mark of all true science, that it destroys by fulfilling.

However it may have escaped recognition, it is certain that theology has been at work for some time now with methods of inquiry similar to those employed by natural science. And it has already partially succeeded in working out a reconstruction of some important departments from the stand-point of development. If the student of science will now apply to theology for its Bible, two very different books will be laid before him.

The one is the Bible as it was accepted by our forefathers; the other is the Bible of modern theology. The books, the chapters, the verses, and the words are the same in each, yet in the meaning, the interpretation, and the way in which they are looked at, they are two entirely distinct Bibles. The distinction between them is one which science will appreciate the moment it is stated. In point of fact, the one is constructed like the world according to the old cosmogonies; the other is an evolution. The one represents revelation as having been produced on the creative hypothesis, the Divine-fiat hypothesis, the ready-made hypothesis; the other on the slow-growth or evolution theory. This last—the Bible of development—is the Bible of modern scientific theology. It is not less authoritative than the first, but it is differently authoritative; not less inspired, it is yet differently inspired.

From its stand-point the Bible has not been made in a day, any more than the earth; nor have its parts been introduced mechanically into the minds of certain men, any more than the cells of their brain. In uttering it they have not spoken as mere automata—the men, though inspired, were *authors*. This Bible has not been given independently of time, of place, or of circumstance. It is not to be read without the philosophic sense which distinguishes the provisional from the eternal; the historic sense, which separates the local from the universal; or the literary sense, which recognizes prose from poetry, imagery from science. The modern Bible is a book whose parts, though not of unequal value, are seen to be of different kinds of value; where the casual is distinguished from the essential, the subordinate from the primal end. This Bible is not an oracle which has been erected; it has grown. Hence it is no longer a mere word-book, nor a compendium of doctrines, but a nursery of growing truths. It is not an even plane of proof-texts without proportion or emphasis, or light and shade, but a revelation varied as Nature, with the divine in its hidden parts, in its spirit, its tendencies, its obscurities, and its omissions. Like Nature, it has successive strata, and valley and hill-top, and mist and atmosphere, and rivers which are flowing still, and hidden ores, and here and there a place which is desert, and fossils too, whose crude forms are the stepping-stones to higher things. In a word, this Bible is like the world in which it is found, natural, human, intelligible in form; mysterious, inscrutable, divine in origin and essence.

With so living a book, theology has again become living. A whole cloud of problems, perplexities, anomalies, and doubts fall before it. No formal indictment is drawn against older views; difficulties are not examined and answered in detail. Before the new stand-point they disappear of themselves. Men who are in revolt against many creeds breathe again in this larger atmosphere and believe afresh, satisfying their reason and keeping their self-respect. For scientific theology no more pledges itself to-day to the interpretations of the Bible of a thousand years ago than does science to the interpretations of Nature in the time of Pythagoras. Nature is the same to-day as in the time of Pythagoras, and the Bible is the same to-day as a thousand years ago. But the Pythagorean interpretation of Nature is not more impossible to the modern mind than are many ancient interpretations—those of Genesis among others—to the scientific theologian.

This is no forced attempt, observe, to evade a scientific difficulty by concessions so vital as to make the loss or gain of the position of no importance. This change is not the product of any destructive criticism, nor is this transformed book in any sense a mutilated Bible. It is the natural result of the application of ordinary critical methods to documents which, sooner or later, must have submitted to the process and from which they have never claimed exemption.

But to return to Genesis. Those modern critics, believing or unbelieving, who have studied the Biblical books as literature—studied them, for instance, as Professor Dowden has studied Shakespeare—concur in pronouncing the Bible absolutely free from natural science. They find there history, poetry, moral philosophy, theology, lives and letters, mystical, devotional, and didactic pieces; but science there is none. Natural objects are, of course, repeatedly referred to, and with unsurpassed sympathy and accuracy of observation; but neither in the intention of any of the innumerable authors nor in the execution of their work is there any direct trace of scientific teaching. Could any one with any historic imagination for a moment expect that there would have been? There was no science then. Scientific questions were not even asked then. To have given men science would not only have been an anachronism, but a source of mystification and confusion all along the line. The almost painful silence—indeed, the absolute sterility—of the Bible with regard to science is so marked as to have led men to question the very beneficence of God. Why was not the use of the stars explained to navigators, or chloroform to surgeons? Why is a man left to die on the hill-side when the medicinal plant which could save him, did he but know it, lies at his feet? What is it to early man to know how the moon was made? What he wants to know is how bread is made. How fish are to be caught, fowls snared, beasts trapped and their skins tanned—these are his problems. Doubtless there are valid reasons why the Bible does not contain a technological dictionary and a pharmacopœia, or anticipate the "Encyclopædia Britannica." But that it does not inform us on these practical matters is surely a valid argument why we should not expect it to instruct the world in geology. Mr. Huxley is particular to point out to us that the bat and the pterodactyl must be classified under the "winged fowl" of Genesis, while at a stretch he believes the cockroach might also be included. But we should not wonder if the narrator did not think of this.

Scientific men, apparently, need this warning, not less than those whom they punish for neglecting it. How ignorantly, often, the genius of the Bible is comprehended by those who are loudest in their denunciations of its positions otherwise, is typically illustrated in the following passage from Haeckel. Having in an earlier paragraph shown a general harmony between the Mosaic cosmogony and his own theory of creation, he proceeds to extract out of Genesis nothing less than the evolution theory, and that in its last and highest developments :

> Two great and fundamental ideas, common also to the non-miraculous theory of development, meet us in this Mosaic hypothesis of creation with surprising clearness and simplicity—the idea of separation or differentiation, and the idea of progressive development or perfecting. Although Moses looks upon the results of the great laws of organic development . . . as the direct actions of a constructing Creator, yet in his theory there lies hidden the ruling idea of a progressive development and a differentiation of the originally simple matter.*

With the next breath this interpreter of Genesis exposes "two great fundamental errors" in the same chapter of the book in which he has just discovered the most scientific phases of the evolution hypothesis, and which lead him to express for Moses "just wonder and admiration." What can be the matter with this singular book? Why is it science to Haeckel one minute and error the next? Why are Haeckel and Mr. Huxley not agreed, if it is science? Why are Haeckel and Mr. Gladstone agreed, if it is religion? If Mr. Huxley does not agree with Haeckel why does he not agree with Mr. Gladstone?

George MacDonald has an exquisite little poem called "Baby's Catechism." It occurs among his children's pieces :

> Where did you come from, baby dear?
> Out of the everywhere into here.
>
> Where did you get your eyes so blue?
> Out of the sky as I came through.
>
> Where did you get that little tear?
> I found it waiting when I got here.
>
> Where did you get that pearly ear?
> God spoke, and it came out to hear.
>
> How did they all just come to be you?
> God thought about me and so I grew.

* Haeckel, "History of Creation," vol. i, p. 38.

For its purpose what could be a finer, or even a more true, account of the matter than this? Without a word of literal truth in it, it would convey to the child's mind exactly the right impression. Now conceive of the head nurse banishing it from the nursery as calculated to mislead the children as to the origin of blue eyes. Or imagine the nursery governess who has passed the South Kensington examination in Mr. Huxley's "Physiology" informing her pupils that ears never "came out" at all, and that hearing was really done inside, by the fibers of Corti and the epithelial arrangements of the maculæ acusticæ. Is it conceivable, on the other hand, that the parish clergyman could defend the record on the ground that "the everywhere" was a philosophical presentation of the Almighty, or that "God thought about me" contained the Hegelian Idea? And yet this is precisely what interpreters of Genesis and interpreters of science do with the Bible. Genesis is a presentation of one or two great elementary truths to the childhood of the world. It can only be read aright in the spirit in which it was written, with its original purpose in view, and its original audience. What did it mean to them? What would they understand by it? What did they need to know and not to know?

To expand the constructive answers to these questions in detail does not fall within our province here. What we have to note is, that a scientific theory of the universe formed no part of the original writer's intention. Dating from the childhood of the world, written for children, and for that child-spirit in man which remains unchanged by time, it takes color and shape accordingly. Its object is purely religious, the point being, not how certain things were made, but that God made them. It is not dedicated to science, but to the soul. It is a sublime theology, given in view of ignorance or idolatry or polytheism, telling the worshipful youth of the world that the heavens and the earth and every creeping and flying thing were made by God. What world-spirit teaches men to finger its fluid numbers like a science catalogue, and discuss its days in terms of geological formations? What blindness pursues them, that they mark the things he made only with their museum-labels, and think they have exhausted its contribution when they have never even been within sight of it? This is not even atheism. It is simple illiterateness.

The first principle which must rule our reading of this book is the elementary canon of all literary criticism, which decides that any interpretation of a part of a book or of a literature must be controlled by the dominant purpose or *motif* of the whole. And, when one investigates that dominant purpose in the case of the Bible, he finds it reducing itself to one thing—religion. No matter what view is taken of the composition or authorship of the several books, this feature secures immediate and universal recognition.

Mais s'il en est ainsi (says Lenormant), me demandera-t-on peut-être, Où donc voyez-vous l'inspiration divine des écrivains qui ont fait cette archéologie, le secours surnaturel dont, comme chrétien, vous devez les croire guidés? Où? Dans l'esprit absolument nouveau qui anime leur narration, bien que la forme en soit restée presque de tout point la même que chez les peuples voisins.*

[Trans.—But if it is so, I may be asked, where, then, do you see the divine inspiration of the writers who made this archæology, the supernatural aid by which you, as a Christian, must believe they were guided? Where? In the absolutely new spirit that animates their narration, although the form of it may still be in almost every point the same as with the neighboring peoples.]

A second principle is expressed with such appositeness to the present purpose, by an English commentator, that his words may be given at length:

There is a principle frequently insisted on, scarcely denied by any, yet recognized with sufficient clearness by few of the advocates of revelation, which, if fully and practically recognized, would have saved themselves much perplexity and vexation, and the cause they have at heart the disgrace with which it has been covered by the futile attempts that have been made, through provisional and shifting interpretations, to reconcile the Mosaic Genesis with the rapidly advancing strides of physical science. The principle referred to is this: matters which are discoverable by human reason, and the means of investigation which God has put within the reach of man's faculties, are not the proper subjects of Divine revelation; and matters which do not concern morals, or bear on man's spiritual relations toward God, are not within the province of revealed religion.†

Here lies the whole matter. It is involved in the mere meaning of revelation, and proved by its whole expression, that its subject-matter is that which men could not find out for themselves. Men could find out the order in which the world was made. What they could not find out was, that God made it. To this day they have not found that out. Even some of the wisest of our contemporaries, after trying to find that out for half a lifetime, have been forced to give it up. Hence the true function of revelation. Nature in Genesis has no link with geology, seeks none and needs none: man has no link with biology, and misses none. What he really needs and really misses—for he can get it nowhere else—Genesis gives him; it links Nature and man with their Maker. And this is the one high sense in which Genesis can be said to be scientific. The scientific man must go there to complete his science, or it remains forever incomplete. Let him no longer resort thither to attack what is not really there. What is really there he can not attack, for he can not do without it. Nor let religion plant positions there which can only keep science out. Then only can the interpreters of Nature and the interpreters of Genesis understand each other.—*Nineteenth Century.*

* "Les Origines de l'Histoire," Préf., xviii.

† Quarry, "Genesis," pp. 12, 13.

THE HAND-WORK OF SCHOOL-CHILDREN.*

By REBECCA D. RICKOFF.

AN exhibition of children's hand-work was held last spring in one of the public schools of Yonkers. The large assembly-room of the school-house was filled with lines of tables, upon which were displayed the various articles to be exhibited. The room was handsomely decorated, and the tables were daintily covered and adorned with bunches of flowers. For each class-room in the house there was set apart one or more tables upon which was placed, under the direction of the class-teacher, the work of that class, the whole presenting the appearance of a very successful and pretty fair.†

While this exhibition was given in the school-house, and under the direction of the school superintendent and teachers, with the sanction and encouragement of the school board, and though the work was done by pupils of the school only, none of the things were made in the school, excepting the colored paper busy-work of the youngest children and, of course, the drawing. All the other things were made *at home*, and expressly for this exhibition. Too much credit can not be given to the teachers who undertook and carried forward this enterprise, it being entirely outside of the regular school-work. There were many difficulties to overcome. Numbers of the children were sure they could not make anything; but, by conversations with them about what they had done or seen done, and what they would like to do, by constant encouragement to at least attempt something, and advice as to ways and means, and especially by enlisting the pride of the pupils in this, which was to be peculiarly *their* exhibition, independent of school instruction, most of the children were induced to undertake something.

The next difficulty was to prevail upon them to persevere and complete the thing commenced, many of them beginning a half-dozen things before completing one. This failing, so common to all, was well dealt with by this exhibition, in that the necessity to have an article ready by a given day forced the child to exercise his own will-power in deciding upon and completing some one thing, and thus became a good moral lesson. The greatest care was taken by the teachers to impress upon the children the credit of honest work. They were advised to consult with relatives and friends as to what

* A report upon the Yonkers Industrial Exhibition of Children's Work, read before the Committee of Industries of the Industrial Educational Association of New York.

† The exhibition here described was given in school No. 2, of which Miss Dresser is principal, to whom and to her assistant teachers great credit is due. Similar exhibitions were given the previous year, in this school and also in school No. 6, of which Miss Spencer is principal, and equal credit is due to her and her assistants.

to make and how to make it, but were honor-bound to refrain from accepting any help in the work itself; and it is believed by all interested in the exhibition that the exceptions to strict honesty and truthfulness in regard to the making of the articles were very rare.

The exhibition was open during the day and evening, and the patrons and friends of the schools came in hundreds to see it. Your committee were among the visitors, and were so deeply impressed with the importance of this exhibition in relation to the work of our Association that we determined to make a list of *the different kinds of things* exhibited, and the ages of the children who made them, with a view of forming from this list some estimate of what children can make and like to make at different stages of growth and development. It is one of the aims of this Association to form a graded system of manual training, and such data as can be obtained from exhibitions of this kind would be invaluable for that purpose. Superintendent Gorton having promised us ample facilities for making the list at another visit when the rooms would not be so crowded, we gave ourselves up to listening to the comments of the visitors; and their lively interest and intelligent appreciation of the exhibit convinced us that it needs only such exhibitions to create a public sentiment in favor of a movement in this direction. Many parents, desiring to give help and sympathy to their children in their school-work, find themselves at a disadvantage. It is seldom that even a well-educated and intelligent parent is conversant with the last new methods of the schools, and his suggestions and help, not being in accord with them, are looked upon by the children as incorrect or old-fashioned. Thus many fathers and mothers are made to feel at times that they are cut off from taking part in their children's education. But here, in this exhibition, is something that bridges the gap between home and school, something the parent knows all about—how that bread was mixed, that garment fashioned, that ladder whittled out, that little wagon painted. Not only can they understand, but they themselves were the teachers. This can become a great power for good to the community through the avenues both of the school and the home.

We subjoin a list in which are noted down only those articles most characteristic of the grade in which they were found, and in each grade the age of the children is given. There were some remarkable and elaborate toys and fancy-work showing skill, ability, even genius for invention and great application and perseverance; but these were the efforts of children having special capacities or unusual opportunities. It is, of course, a great gain to the community that those having particular aptitudes for industrial pursuits should be encouraged and cultivated; but this Association has, besides this practical aim, another which is broader and more far-reaching, and that is, to find principles by which manual training may be adapted to large classes of ordinary children. The wonderful things that remarkable children can do show us where great successes lie, but what we most need at present are the common things showing us how and where the multitudes of children walk, or rather stumble, along. And we would here respectfully suggest the advisability of securing such lists from exhibitions of this kind that may be held in different sections of the country, to be kept among the records of this Association for reference, until we shall have obtained data sufficient to guide us in our work. In such a collection there will doubtless be much worthless material and many duplicates, but will not the suggestive facts be worth the trouble of gathering them? That a thing is many times duplicated by children of the same age will indicate it as something suited to that age; that at certain other ages the work is below the average as to number of articles, or unsuited to the growth of the children, will indicate a want of proper occupation or true development of children of that age.

Among the specimens of the work of the first year in school, by children five or six years old, we observed, in the girls' department, a doll's muff of white fur; dolls' aprons, one of silk trimmed with lace; dressed dolls; a doll's bonnet, creditably made up of scraps of fur, lace, and ribbon, and a tiny feather; a doll's apron, with high neck, long sleeves, and a yoke; a cushion and a lamp-mat in colors; coarse lace-work of different kinds; a child's apron, and a child's petticoat.

Among the most noteworthy articles in the boys' department were a boat hollowed out, with rudder and seats; a bob-sled, made by connecting two tiny sleds by a strip of board, which was fastened with two screws and nuts; a cube of wood, with a number of squares engraved on each face; bow and arrow; a ladder of thirteen steps evenly adjusted; a rake, made of two pieces of other toys, with bits of iron wire for teeth—the wood had split in the making, and was mended with screws; a screen window; a chair and table, apparently made from kindling-wood with a penknife; a wagon, made of a rough box, with ends of spools for wheels; a toy pump, quite equal to those of its kind that are sold in the shops, with spout and handle correctly inserted.

In the second school year, the children of which were six or seven years old, the boys exhibited a rake, more laboriously made, but showing less ingenuity than the rake previously mentioned; several ladders, of different patterns, but with steps of uniform length and spacing correct in all; an invention—a gun made from two triangular pieces of unplaned board, a piece of old bucket-hoop, and the top of an old pepper-box, with a little stick for a projectile; a tip-cart—a box with two old furniture-rollers for wheels, two screws, two small strips of wood to hold the tongue, and two bits of twine serving as hinges to the tail-board; a shapely keel-boat, of sharp model, with mast, sail, and pennant, standing in two supporting blocks, and the whole easily held in a lady's hand; a handsome bracket, made by a colored boy too old for his class, who was supposed to be simple-minded. A boy who was sure he could not make anything brought a wire hanging-basket filled with wood-moss and ferns and a blossoming anemone.

The girls' work of this grade begins to show the effect of training at home, and is more conventional than that of the boys. The specimens included white undergarments, neatly made and trimmed; aprons of various styles; knitted dolls' hoods, lace and crochet work; baby's clothes, crazy-work mats, dressed dolls, bean-bags, pen-wipers, and pin-cushions.

Of the third school year, the children being seven and eight years old, the girls' work did not differ materially from that last described. In the boys' department, wheelbarrows appeared to be a specialty, but we found also saw-bucks, bedsteads, boot-jacks, a gunboat, a cross of wood mounted for wax-work, a fort, and mounted drawings; many houses, made of common pasteboard, with doors, bay-windows, dormer-windows, and porticoes; a boat, noticeable for its neat oars, and its row-locks made of black dress-eyes.

In the products of the next two years, by children from eight to ten years old, while the boys' work was still mainly confined to toys, that of the girls appeared to be growing more practical. Pride in execution was shown in both.

Boys' work: A velocipede, small but complete, with hubs, spokes, felloes, and tires represented by lines of black; a substantial and neatly finished wagon; clothes-horses, step-ladders, saw-bucks, easels, ocean-steamers, and catamarans, seemed to be favorites; several forts were exhibited; a curious vase was ingeniously made from a tomato-can, with a large black spool serving as pedestal, the whole decorated with gilt paper and bright-colored pictures.

Girls' work: Sofa-cushions, pillow-shams, aprons; a white Mother Hubbard dress; machine-work, tucking, lace, darned socks, splashers, a quilt, crazy-work, albums of stamps, and pictures.

In the sixth and seventh years, representing children from ten to fourteen years old, all the work was elaborate and well done, but was participated in by a smaller proportion of the pupils. The work of the boys was less prominent than that of the girls, but was more practical than in previous years.

The *boys' work* comprised chiefly cabinet-work (book-cases, easels, checker-boards, a table), a door-mat of coffee-sacking tufted with rope-ends.

The *girls' work* included excellent plain sewing, exemplified in children's dresses, fine aprons, and underwear; fancy-work (painted cards, embroidered banner-screens, lace, a crib-quilt, an embroidered table-scarf); bread, cakes, pickles, etc. There were many hundreds of other articles in the exhibition, a large majority of them creditable productions, and all representing earnest effort.

One of the noticeable features of the exhibition was an apparent decline in originality of invention and spontaneity of thought after the first year or two at school. Pride in the execution of good work seems to have been exhibited most prominently in the middle period. As the girls grew older and were trained in household and needle and fancy work at home, their products exhibited more variety, but not more novelty, and they continued to contribute specimens till their highest age at school. But, while some work was furnished by girls of over fourteen, very little was exhibited by boys of corresponding age. They found themselves too unskilled to make good specimens, and were too proud to exhibit poor ones. Another fact deserving notice is that, in the work of the boys during the first years of school, there were apparent a love for color and a skill in using it for decoration and design, equal to that displayed by the girls; while in the later years the use of color becomes exceptional with the boys, but still continues to prevail, with evidences of increased skill, in the work of the girls.

When a few days ago we were requested to prepare this report, Superintendent Gorton was consulted, and from him it was learned that this Yonkers experiment was of two years' growth, and that the idea originated in Mount Vernon. The first exhibition of the kind was held in the public-school house of that village nine years ago, and with the exception of two years the exhibitions have since been regularly continued. The parents and citizens have always taken great interest in them, the children have enjoyed and felt pride in them, and the teachers have cheerfully done the extra work. The present principal of the school, Mr. Charles Nichols, heartily approves them as a source of good moral influence.

As results of an investigation of this subject, your committee would sum up as advantages accruing from the exhibition of the home-work of children through the medium of the schools: A bringing together of the home and the school, thus conducing to a better acquaintance between the parents and the teachers; giving to the teacher a better knowledge of the child's home influences and surroundings, thus enabling him to exercise a more intelligent care over the development of the child's moral character; giving to the parents a better insight and new interest in the schools and their management, with an overflowing of the moral influence of school training into homes where intelligent discipline is unknown; a greatly increased respect in all quarters for handicrafts; the diffusion of the principle that in the liberal education of the individual a development of manual skill, as well as a harmonious unfolding of the mental faculties, should be looked after, and that these react favorably on each other in various ways.

The facts were made clear that some children are especially endowed with native capacity for mechanical contrivances, which needs excitation, encouragement, and opportunity for development, in the lack of which their usefulness will be impaired for life; that some children are endowed with great capacity in this direction, while they have but little in any other; that the happiness of every family may be promoted by the disposition and ability on the part of its various members to adapt the material resources within their control to the convenience and comfort of all; that by the cultivation in early childhood of a taste for manual employment there would be found in almost every individual aptitudes for hand-work of one kind or another, which would afford pleasurable pursuits in hours not occupied with the serious affairs of life, and which would contribute to his happiness as well as promote his pecuniary welfare; that such occupations, aside from the main pursuits of life, would aid in forming good habits and good morals; that the children of the poor especially need something to occupy their time and attention out of school-hours, whereby they may be withdrawn from the demoralizing influences of the streets; that it will be wise for this Association to promote the *home industries* of children by all means in their power, one of the most effective being public exhibitions, where a comparison of the results of the industries of the children may be made; that by such exhibitions we shall not only educate the child-contributors, but that they will also educate us and the community.

THE TEETH OF THE COMING MAN.*

By OSCAR SCHMIDT.

THE alternative as to whether man was created or developed can no longer be raised, now that we are exercising the free use of our reason. Man's dentition has to be judged from our experiences made in the mammalian group. Hence, first of all, it is a reduced dentition. True, we do not know the definite stages by which it was attained in man, any more than we do in the case of the anthropomorphoids, and all the other apes of the Old World, but we shall not hesitate to maintain that the ancestors of man possessed a fuller number of teeth, as long as deductions are justified from the observation of facts. Our teeth have decreased in number during the course of our geologico-zoölogical development; we have lost on either side, above and below, two incisors, two premolars, and one molar. By this we transfer ourselves back to those periods from which the jaw of the otocyon has been preserved. Baume, our eminent odontologist, in a recent work which we have repeatedly referred to, has successfully followed and pointed out cases of atavism or reversion in the human

* From "The Mammalia in their Relation to Primeval Times." By Oscar Schmidt. New York: D. Appleton & Co., 1886.

jaw, by tracing cases of "surplus" teeth—and certain dental formations met with in the jaws in a large percentage of cases—back to those portions of the jaw in the animal ancestors of man which have disappeared in the course of ages.

If, in former times, more teeth were met with in the group which was perfecting itself into man, we must be permitted to ask—nay, we are compelled in a purely scientific spirit to ask—whether things have come to a stand-still in this part of our organization, or whether a further reduction is to be anticipated? Man is certainly one of the so-called "persistent species," but he is not unconditionally stationary. He varies as regards dentition. Imperfect as are our statistics on this point, this much is certain, that the cases of disappearance or loss of teeth most frequently concern the so-called wisdom-teeth, and then the outer incisors. We do not, of course, know how often the question has applied to the actual and complete loss of the teeth, or only to some interference with the teeth cutting the gum, occasioned by a limitation of the necessary space. However, it must be remembered that the shortening of the jaw stands in direct correlation with the reduction of the dentition. A prediction of the man of the future is given us by Cope: the lower races of men will retain the dentition of the present day, incisors $\frac{2}{2}$, canines $\frac{1}{1}$, premolars $\frac{2}{2}$, molars $\frac{3}{3}$; while the intellectually higher races will be distinguished by the dental formulas:

$$\text{incisors } \frac{\mathbf{1}}{2}, \text{ canines } \frac{1}{1}, \text{ premolars } \frac{2}{2}, \text{ molars } \frac{3}{3};$$

$$\text{and incisors } \frac{\mathbf{1}}{\mathbf{1}}, \text{ canines } \frac{1}{1}, \text{ premolars } \frac{2}{2}, \text{ molars } \frac{\mathbf{2}}{\mathbf{2}}.$$

We agree with this in so far that, as a rule, the reduction of the dentition—where the disappearance does not affect the whole set of teeth—can be brought into connection with the idea of progress, and many proofs of this have been given in the course of our discussion. Still, this higher faculty of resistance and of acquiring food is not necessarily accompanied by an increase in the power of the adaptability and a perfecting of the intellectual faculties. In the cat we have a more powerful, and hence a higher development of the nature of the rapacious animal than in the dog, with its more old-fashioned form of dentition. Yet who would think of placing cats as intellectually higher than dogs? It is the same with the prospects of the human races. Modifications in the human dentition are sure to take place—as surely as man can not rid himself of his animal ancestors, even though they may be felt to be inconvenient. But progress in the intellectual and moral domain—and here our well-founded idealism steps in—is not dependent upon the possession or the loss of our wisdom-teeth. The correlation is not wanting; but it makes itself felt in an opposite direction. The man who is engaged in making inventions and in scientific pursuits, and is advancing and encouraging all the nobler and more refined enjoyments of life, is not improving the instruments for the acquisition of his food; they deteriorate in his hands—a condition which first began to make its appearance with the invention of cooking. The reduction of the human dentition—which has been of advantage to the species in its struggle for existence—has further increased and changed to a kind of atavism or reversion, since reason, acquired with speech, has made man more and more independent of the direct effects of his natural surroundings.

Hence it is not merely from a purely zoölogical point of view that an inference is formed regarding the future change of the human race. Moreover, we cherish the hope—which is justified by scientific experiences—and the belief, which rests upon the same foundation, and these convince us of the sure advance of humanity, and of the gradual and general diffusion of morality, culture, and well-being among the various races of man.

EARTHQUAKES IN CENTRAL AMERICA.

By M. de MONTESSUS,

OF THE METEOROLOGICO-SEISMIC OBSERVATORY AT SAN SALVADOR.

CENTRAL AMERICA is probably the region of the globe in which the manifestations of volcanic and seismic phenomena are most frequent and continuous. During my residence of four years at San Salvador, I have been able to write the detailed history of twenty-three hundred and thirty-two earthquakes, one hundred and thirty-seven volcanic eruptions, twenty-seven ruins of important towns, and the formation of three new volcanoes. Geographically, Central America, founded on the Cordillera of the Andes, forms a connecting link between the two great continental masses through three successive isthmuses, those of Panama or Darien, Izabal, and Tehuantepec. It descends to the Atlantic in two large wedges, ending in Capes Gracias á Dios and Catocha, and rests abruptly on the nearly rectilinear coast of the Pacific. The base of the Cordillera is of primitive formation, and its western flank, with which we are concerned, is formed of Miocene and Pliocene strata, terminating with Quaternary and modern alluvions and more or less recent volcanic flows.

Parallel with this axis runs the remarkable string of volcanoes which, from Chiriqui in the State of Panama, to Soconusco in Mexico, includes not less than one hundred and forty-three volcanic mountains or craters, thirty of which are active, or have been within the three hundred and sixty-three years that separate us from the Spanish Conquest. They do not present themselves, as is generally believed, upon a straight line or along a volcanic fault, nor even on a line broken at two or three points, but in a zone having borders parallel to the Pacific coast, with an average width of about thirty miles. This formation arises from the fact that Central America has had three successive shores, recording as many periods of least movement in the increase of the Cordillera, to each of which corresponds a line of contemporaneous volcanoes. The most ancient shore was of the Miocene period, when a system of trachytic and basaltic eruptions took place; then in the Pliocene rose the chain of the largest number of extinct volcanoes; while in the Quaternary and modern periods appeared the line of existing volcanoes and of others that have since become extinct. It is apparent, then, that the volcanic force has always been near the shore of the ocean, and has moved successively from the east to the west, so as to be at only a short distance from it, as the Cordilleras in their progressive elevation carried the shore farther in that direction. These views, incontestable to me, are plainly read on the strata of the country.

The system of volcanoes is completed by a chain of lakes alternating with them. The principal lakes are those of Managua and of the roads of Fonseca, the latter of which has been put in communication with the ocean by means of some volcanic convulsion. The roads of Nicoya and Chiriqui seem to me to be of the same origin. This part of the system is surely one of the most remarkable aggregations of lakes and volcanoes in the world, and strikingly reminds us, but on a grander scale, of that of the lakes of Limagne, Issoire, and Brassac, with the chain of the *puys* of Auvergne, which would correspond with the chain of the Marrabios. Starting at the roads of Fonseca, the chain of lakes and volcanoes continues, the former diminishing in importance, to San Salvador and Guatemala. I am not speaking of the numerous picturesque crater-lakes which we meet everywhere in Central America, and which I regard as an accident of no particular importance.

A phenomenon well worthy of attention may be observed at the foot of the chain of volcanoes near Ahuachapan, in San Salvador, in the Ausales, some three or four hundred conical tunnels scattered over a space of about three square leagues, their diameters varying from three or four metres to thirty or thirty-five metres, from which occur, at short intervals, eruptions of vapors, boiling water, and argillaceous mud of many colors. They are grouped by dozens very close together, and poison the plain with their acid and sulphurous emanations. The ground around them resounds under the feet of the traveler, but only along lines which seem to be immediately over the subterranean channels through which the hot water and gases circulate.

From this multiplicity of volcanoes it results that the ground presents a complicated net-work of ancient and modern lava-flows, crossing one another, volcanic alluvions, beds of cinders and tufas, "bad lands," and an extraordinary thermal activity. There also follows a remarkable frequency of earthquakes and subterranean noises, called *retumbos.* I estimate the average number of shocks felt annually in Central America at two hundred and fifty. Several conclusions may be drawn from the study of the twenty-three hundred and thirty-two earthquakes that have been registered since the conquest. First, contrary to the opinion generally prevailing from Chili to Mexico, the tremors occur about alike through the whole year, and not principally at the transitions between the rainy and dry seasons. But, to perceive this clearly, it is necessary to leave out of the account some series of earthquakes that mask the truth, such as that of December, 1879, at San Salvador, in which more than seven hundred shocks occurred in ten days, and which was the prelude to the appearance of a new volcano in the center of Lake Ilopango. With this precaution, a tendency to equality may be observed between the several months, and I am satisfied that a term of four years will be sufficient to make this equality plain. The same may be said of the *retumbos.* The maximum of eruptions appears to occur in July. Kluge puts it in August for the whole globe. The coincidence which the same author has predicated between the maxima of auroræ boreales and sun-spots and of volcanic and seismic manifestations has not been historically verified in Central America. The minute study of twenty years of observations at the Institute of Guatemala and my own observations at San Salvador have proved to me that, if the movements of the crust of the earth are connected with those of the barometer, the law of the relation is deeply hidden. I do not deny it, but I have observed nothing analogous to what Scrope believes he has established for Stromboli, and Waltershausen for Etna. Earthquakes and *retumbos* are apparently more frequent at night than in the daytime. I say apparently, because it may be that manifestations, quite perceptible in the stillness of the night, pass unobserved amid the bustle of the day. From what I have seen, I think I can affirm that the signs of terror given by domestic animals are more marked the longer the shock lasts, and that without reference to its intensity.

While I do not think that it is possible in the present state of knowledge to predict earthquakes, I believe that the phenomena are frequently connected with an indefinable aggregation of atmospheric conditions which, subjected to many years of study, might lead to the discovery of some law. This is so true that persons who have lived long in the country often say when they meet, without knowing why, "There will be an earthquake to-day"; and they are seldom mistaken. Towns in Central America, situated near active volcanoes, have much less to fear than those which, being in the dangerous zone, are more distant from them. This may be proved by the local history. Guatemala was destroyed seven times, between 1541 and 1773, while it was near the extinct volcano of Agua; but it has not suffered since 1775, when it was removed to its present position near the active volcano of Fuego, of which forty-four eruptions have taken place. Izalco, built on the flanks of Izalco, a volcano which has had since its formation in 1770 an eruption about every twenty minutes and twenty-one considerable ones, has never been destroyed, nor have Santa Anna, San Miguel, and Masaya, on the slopes of the volcanoes of the same names, which have had respectively seven, ten, and six great eruptions. San Salvador, which is built on the slopes of Quetzaltepec, has been wholly destroyed fourteen times, the last time on the 19th of March, 1873. This volcano may be regarded as extinct, for it has had only one eruption since the conquest, that of the 30th of September, 1659, when the cinders flew as far as Comayagua, the capital of Honduras, and the lavas formed the immense "bad land" (*cheyre*) of Quetzaltepec and buried the Indian city of Nejapa. The principal of the eight craters of Quetzaltepec (or San Salvador as it is otherwise called) is remarkable for its perfect regularity and its size, six hundred metres in diameter and depth. The bottom is occupied by an almost inaccessible lake. The appearance of the volcano of Lake Ilopango, in 1879–'80, probably saved San Salvador from a fifteenth destruction. Omoa and Jucuapa, built on the slopes of the extinct volcanoes of the same names, were destroyed on the 4th of August, 1856, and the 2d of October, 1878.

In a work published by the Government of San Salvador on "Earthquakes and Volcanic Eruptions in Central America," in which I have given a detailed history of the phenomena, I have been able to show, from original documents, that the destruction of Guatemala, on the night of the 10th and 11th of September, 1541, was due, not to an eruption of mud from the extinct volcano of Agua, as some authors suppose, but to the rupture under the weight of the water, assisted by an earthquake, of the walls of its crater, which had been filled by the extraordinary rains of the preceding days. The eruption of Pacaya, on the 18th of February, 1651, and the ruin of Guatemala, which it occasioned, were accompanied by the spectacle of frightened wild animals seeming to seek the protection of man, as they did also during the eruption of Coseguina on the 20th of January, 1835. The year 1770 witnessed the rise of Izalco—"the Lighthouse of the Pacific"—a magnificent volcano, whose eruptions have since followed one another uninterruptedly about every quarter of an hour, with explosions that are frequently heard for ten leagues around. The great eruption of Coseguina, on the 20th, 21st, 22d, and 23d of January, 1835, perhaps one of the most formidable eruptions mentioned in history, the cinders from which flew as far as to Vera Cruz, Havana, Carácas, and Bogotá, was heard over the same circle of seventeen hundred miles in diameter. The well-proved coincidence that these eruptions began on the same day with those of the Chilian volcanoes of Aconcagua and Corcovado, all three situated in the chain of the Andes, is too remarkable not to attract attention. The environs of the active volcano of Momotombo from the 1st to the 20th of April, 1850, witnessed the emergence of the new volcano of Las Pilas, now extinct.

A fact remarked by Humboldt as accompanying the earthquake of the 4th of November, 1799, at Cumana, was also observed at Guatemala on the 8th of December, 1859. I refer to a sudden and considerable deviation of the magnetic needle, which still continues. To account for it, I propose the theory of a change by the shock in the disposition of the neighboring strata.

A series of more than seven hundred shocks between the 20th and 31st of December, 1879, two of which were disastrous, and which caused much alarm at San Salvador, was the prelude to the appearance, in the neighboring Lake of Ilopango, of a new but ephemeral volcano, whose mass caused the lake to overflow its banks and to produce a terrible inundation in the valley of the Rio Jiboa. The event has been made the subject of a detailed and very interesting study by Messrs. Goodyear and Rockstroh. I will only observe respecting it that two hundred and thirty-seven explosions took place on the 4th of March, 1880, between twenty-five minutes past nine and twenty minutes past ten in the morning, and eight hundred and ninety-seven explosions between eighteen minutes past seven in the evening of the following day and seventeen minutes past three on the next morning.

The *retumbos* heard at San Salvador and in Colombia on the 27th of August, 1883, were doubtless the echo of the eruption of Krakatoa. I am satisfied that if such a work as I have performed for the small fraction of Central America were done for the whole system of the Cordilleras, from Cape Horn to Behring Strait, and if the different governments would establish meteorologico-seismic observatories, like the one I have directed for four years at San Salvador, it would be possible, in this home of volcanic activity, to form some sound theory of these interesting and terrible phenomena, and perhaps to find some means of announcing them beforehand, as we predict storms on the Atlantic.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

THE GEMS OF THE NATIONAL MUSEUM.

By GEORGE F. KUNZ.

THE collection of gems exhibited by the National Museum at the Cincinnati and New Orleans Expositions is now on exhibition at the rooms of the Museum in Washington. This much-needed accession, representing a small part of the appropriation for the World's Fair, promises to be one of the most attractive and instructive features of the museum. The large number of visitors who examined the collection, both at the fairs and in its present location, can testify to its interesting character. Although a mere beginning, it is the most complete public collection of gems in the United States. It is contained in two flat plate-glass exhibition-cases, the gems being neatly marked with printed labels, and arranged on velvet pads with a silk-rope border. The diversity, brilliance, and richness of Nature's brightest colors displayed render the whole effect a very attractive and pleasing one. The collection begins with a suite of glass models of the historical diamonds, followed by a series of diamonds in their natural state, among which is an interesting octahedron, eighteen carats in weight.* These specimens are good illustrations of the form from South Africa, though of little commercial value as gems. One dozen other crystals from one quarter to one carat in weight complete a representative set of form and occurrence in that region. Next we have a very neat set of a dozen more crystals, small but choice, principally from India and Brazil, and formerly belonging to the Mallet collection. One of these is a perfect cube, a form peculiar to Brazil, while another is twinned parallel to the octahedron. Another stone of one carat is only half cut, and for comparison we have a stone of about the same weight completely cut.

Among the sapphires we find a carat, oblong stone of dark-blue color, from the Jenks mine, Macon County, North Carolina, which has yielded a few fair sapphires, yellow, violet, and blue, and a few rubies, some of the finest of which were in the Leidy collection; also the first stones found here, the dark-brown, asteriated sapphires, described in "Transactions of the New York Academy of Sciences," March, 1883, and two other cut stones weighing from four to eight carats. These all show a slight bronze play of light on the dome of the cabochon in ordinary light, but under artificial light they all show well-defined stars, being really asterias or star-sapphires, and not cat's-eyes, as would seem at first glance. There are also two cut stones, light blue and light green, weighing one and two carats respectively, which, for light-colored sapphires, are perhaps, when cut, brighter than those from any other locality. The cutting of one of these gems has given it a remarkable luster. They are found in the sluice-boxes at and near Helena, Montana. Following are two broken crystals of the dark-green sapphires from the quite recent find at the Hills of Precious Stones in Siam, beautifully dichroitic, being green and blue when viewed in different axes. An asteria of good blue color, measuring nearly one inch across, a beautiful two-carat ruby-asteria, and a small three-quarter-carat ruby, of fair color, complete the corundum gems.

* Gems are generally bought and sold by the weight, called a *carat*, which is equal to about 3·168 troy grains. It is usually divided, however, into four diamond or pearl grains, each of which is ·7925 of a true grain. Fractions of a carat are also known as fourths, eighths, sixteenths, thirty-seconds, and sixty-fourths. The weight of the carat formerly differed slightly in different countries, and this diversity finally led a syndicate of Parisian jewelers, goldsmiths, and gem-dealers, in 1871, to propose a standard *carat*. This was subsequently confirmed by an arrangement between the diamond-merchants of London, Paris, and Amsterdam, fixing the uniform value of the *diamond* (?) carat at ·205 grain.

The series of spinels is well chosen and varicolored: it consists of a long two-carat stone of smoky-blue color; an oblong almandine-colored stone of three carats, an inky stone of one and a half carat, a half-carat ruby spinel of fair color, a pretty rubicelle of three quarters of a carat, and a suite of crystals of the ruby-colored spinel from Ceylon and Burmah. We have also a cut Alexandrite (so called after the Czar Alexander I), from the original Russian locality. This is of fair color, but the wonderful Ceylonese gems of recent years have really given to this phenomenal variety of chrysoberyl, which changes from green to red under artificial light, its present high rank among gems. There is a six-carat typical chrysoberyl, finely cut (the chrysolite of the jeweler), truly, as the name indicates, golden beryl, and a dark-green one of that shade repeatedly sold as Alexandrite, though it does not change color by artificial light. A set of seven rough fragments from Brazil is instructive by comparison.

Among the beryls we have a flawed emerald of ten carats, that well illustrates the typical color, as does a pear-shaped drop of about the same weight and quality. There is also a crystal that has been in the institution for many years, labeled from New Mexico. It is evidently not from that locality, for no other such occurrence is on record, and we must suspect that the label is a misnomer, since the crystal has unmistakable signs of Muso (New Granada) origin. An emerald crystal two inches long, one of a series of minerals brought by Professor J. D. Dana from Peru when with the Wilkes Exploring Expedition, is historically interesting. It was purchased by him in the streets of Callao. In the same series are two good cut beryls, one six carats in weight, of a light-green color, another one-carat light-blue one from Royalston, Massachusetts, and perhaps the finest specimen ever found, at the Portland (Connecticut) quarries, fifteen carats in weight, and of such a rich, deep sea-blue color as almost to rival in splendor the matchless three-carat Brazilian blue-stone that is in the same case.

A fine blue crystal from Mourne Mountain, Ireland, is interesting for its locality and deep color. Stoneham, Maine, has contributed a two-carat white cut stone and a similar fragment; while Siberia is represented only by a common white stone of about six carats' weight.

Next comes a series of the emerald-yellow and yellowish-green varieties of spodumene (variety Hiddenite), embracing lithia emerald in the rough, and three cut stones of the same, weighing from a quarter to three-quarters of a carat, and varying in color from green to yellowish-green, from Stony Point, North Carolina; also a quarter-carat light-yellow and a one-carat golden-yellow spodumene of the variety resembling chrysoberyl, described by Pisani, of Paris, in "Comptes Rendus" for 1877, from Brazil. The white cut phenakite of three carats' weight, from Russia, is of rare occurrence, but has recently been found at two localities in Colorado.

The tourmalines include a dark-red gem (rubellite) of six carats' weight, and good color; two light-red ones of one half carat each, and a fine dark-blue one (indicolite) of three eighths carat; four long bottle-green (called Brazilian emeralds) of two carats each; a half-carat white achroite; two olive-green stones of two carats each; and two sections of green crystals that have red centers. This difference of color between the outer and inner crystals is peculiar to tourmalines, as many as three colors being found in one crystal. All these are from Brazil. The well-known domestic localities are represented by an oblong, table-cut, light-green stone from Paris, Oxford County, Maine, that once held a conspicuous place in the collection of Dr. Joseph Leidy, which, unfortunately, had to be scattered. From Auburn, Maine, a locality quite recently discovered, we have a one-carat blue indicolite, two lavender-colored stones of one carat each, a light emerald-green stone of three quarters of a carat, and as handsome as an emerald by artificial light, and also a suite of several dozen loose crystals of various colors. The neighboring two-carat yellow and three-carat yellowish-brown cut stones are from Ceylon. The fine two-inch grass-green crystal and one-inch bluish-green crystal are also part of the treasure brought home by Professor Dana from the Wilkes Expedition of 1838–'42.

A six-carat blue and two-carat sherry-colored topaz from Siberia are exceedingly brilliant, but the domestic reputation is well sustained by the cinnamon-tinted fifteen-carat cut stone from Pike's Peak, Colorado, which is not surpassed in beauty by the brilliant white four-carat (Minas Novas) from Minas-Geraes, in Brazil. A series of crystals that have been "heated," follows, varying in color from dark pink fading into white according to the degree of calorification.

Among the garnets are ten flat, brilliant cut stones, four carbuncles, and six rose-colored, from Bohemia; six Tyrolese red garnets, two essonites (usually sold as hyacinths by the jewelers), four carats and a quarter carat from Ceylon, and a series, cut and uncut, from New Mexico, which furnishes the finest garnets in the world in point of color. In addition to these we notice a two-carat demantoid (green garnet or Uralian emerald) from Bobrowska River, Syssersk, in the Urals, and a brownish-green one-carat stone from the same locality.

From New Mexico we have a fine yellowish-green peridot or olivine, called chrysolite by the mineralogist, but not by the jeweler, and known as "Job's Tears" locally (from their pitted, tear-like appearance), while the Orient is represented by a beautiful olive-green cut stone.

From the zircons or jargoons we may single out for remark a number of small cut stones, yellowish-brown, pink, bluish-green, and white, the latter color being often produced by heating. Stones of this kind were at one time used for incrusting watches, which were then sold as diamond-incrusted. Next we observe a fine, rich, hyacinth-colored gem (the true hyacinth of the mineralogist), a long, two-carat green, a yellowish-green, and a brownish-green three-carat stone, all from Ceylon. The two carat axinite from Dauphiny is one of the rarest of gems. A six-carat yellowish-green epidote from the Knappenwand, the well-known locality in Tyrol, should be mentioned.

Here, too, is a one-fourth-carat idocrase from Ala, in Piedmont. This mineral, which received the name vesuvianite, because it is found among the formations in the lava at Vesuvius, is sold by the Neapolitan jewelers, and used to make the letters I and V in the manufacture of initial or sentimental pieces of jewelry. The same mineral is found at Sandford, Maine, and other localities here, but rarely in gem form.

Iolilite (dichroite, cordierite), or water-sapphire (*saphire-d'eau*), as it is also called, is here seen in the form of a flat-cut stone, of two carats' weight, from Ceylon, and a cube, one-fourth inch square, from Bodenmais, Bavaria. These are not comparable with one found at Haddam, Connecticut, that was worn as a charm by the late Dr. Torrey. This stone has dichroitic properties: if viewed in one direction it appears blue; if in another, pure white.

The five-carat titanite, or yellow sphene, is from the Tavetchthal, in the Tyrol. This gem shows the play of colors peculiar to the diamond. Specimens have also been found at Bridgewater Station, Pennsylvania. There are three long, yellowish-brown andalusites, of two, one, and three-fourths of a carat weight, at times so dichroitic that they have been offered in London as Alexandrites. These are from Brazil, where fine green ones are also obtained.

Next in order is a light-green diopside, from De Kalb, New York, a locality which has yielded twenty-carat gems, of rich oily-green color, equal to the one-carat cut stone from Ala, in Piedmont.

A small, long, one-carat cyanite, from Russia, is noteworthy, as is also the suite of opals, consisting of two noble cut stones, from Hungary, and a polished slab of the light matrix from the same place, beautifully mottled with opalescent spots; a set of over twenty gems, white, yellow, and brown, from Querétaro, Mexico; and two fair, noble opals from Honduras, together with a one-inch, lusterless cut stone; three pieces of blue opal, in the impure brown limonite, or ironstone matrix, from the Baricoo River, Queensland, Australia, termed opaline by the jewelers, and also a cut stone from the same locality.

Of turquoise, we have a bluish-green piece, one inch and a half long, cut into a flat cabochon stone, from Los Cerrillos, New Mexico, a fine suite of the mineral in the matrix, recently brought on by Major J. W. Powell, from New Mexico, and a set of twenty-four gems from Persia, showing all the characteristic gradations of color between blue and green; a curious half-inch cabochon cut stone, and a piece one inch long in the matrix, from Arabia, noticeable for the pleasing contrast of the bluish-green stone on the background of the chocolate-colored matrix.

Hematite is exhibited, cut in the form of balls and in a cut intaglio, and a cut, one-carat rutile, from Alexander County, North Carolina; these so closely resemble the black diamond in color and luster as to have been mistaken for it when first found.

A dark, almost black hypersthene, from Norway, shows a pleasing bronze-like reflection on the dome of the cabochon. One of the most instructive of the series is a quantity of gem-gravel from Ceylon, containing sapphires of various colors, chrysoberyl, zircon, quartz, and other stones.

A series of the American stone, Thompsonite, found as pebbles in the Lake Superior region, presents some fine cut stones, with the circles from one fourth to three fourths of an inch across. A few large, polished pieces measure over one inch across. Some small pebbles of Lintonite found with the Thompsonite are also polished.

The quartz array is very instructive: it begins with a two-and-a half-inch Japanese crystal ball, and an eagle seal three inches high, of Russian cutting; cut citrines, cairngorm, and the so-called smoky, Saxon, or Spanish topaz, eleven of the dark-purple amethysts from Siberia, often wrongly called Oriental amethysts, and a set of seven from Brazil, show all the changes from light pink to dark purple.

Perhaps the most unique gem of the collection is a piece of amethyst that was found at Webster, North Carolina, and deposited here by Dr. H. S. Lucas. The present form is just such as would be made by a lapidary in roughly shaping a stone, preliminary to cutting and polishing it. It now measures seven centimetres in length, six centimetres in width, four centimetres in thickness, and weighs 136·5 grammes. It was turtle-shaped when found, and this was said to have been the work of prehistoric man. This shape was unfortunately destroyed by chipping it to its present form. It is perfectly transparent, being slightly smoky and pale at one end, and it also has a smoky streak in the center. This coloring is peculiar to the amethyst, however. There are also a three-quarter-inch yellowish quartz cat's-eye from Ceylon, and a three-carat green one from Hoff, Bavaria, and a native Indian necklace from Ceylon, composed of numerous yellowish quartz cat's-eye beads of about three carats each.

We have, then, a beautiful series of the brown-quartz cat's-eyes, so-called crocidolite cat's-eyes (also called tiger-eyes), in fine slabs, balls, buttons, etc., which is really a combination of crocidolite fibers coated with quartz. This incasing renders it harder than unaltered crocidolite, which is to be seen here together with it. All these are from South Africa. Superb rutilated quartz (sagenite, *flèche d'amour*, Venus-hair stone, or Love's arrows), in the rough and in cut form, are from North Carolina. Rhode Island contributes black hornblende blades in quartz, and green actinolite in the same (the Thetis-hair stone of Dr. Jackson). The actinolite, when in straight layers in the quartz, occasionally forms a quartz cat's-eye, if cut across the fibers.

The large pieces of black onyx, chrysoprase, carnelian, and sardonyx, the series of agates, of various colors, are cut into a variety of forms; the fine three-inch-square slab of "gold quartz," of the jewelers, is from Grass Valley, California.

Fine avanturine quartz, with spangles of mica in a rich reddish-brown quartz, from Russia, vases of which are often worth thousands of dollars; and a fine green avanturine, called imperial jade by the Chinese, and more esteemed by them than any of the true jades deserve attention. The series of fifteen small Indian mocha-stones is very attractive; the black, moss-like markings are relieved by the red spots in the gray body of the stone, thus presenting a surface beautifully diversified. A rich, brown, speckled jasper is worthy of notice. The two cut moldavites (Moravian bottle-glass), about one inch across, are of rare occurrence. They are transparent, dark-green obsidians, from Moravia, for which worthless green bottle-glass has sometimes been sold.

The two sun-stones from Norway—the largest one and a half inch long, the other a three-quarter-inch cut cabochon—are indeed fine, but a cut stone of the same material, over one inch long, from Delaware County, Pennsylvania, is nearly equal to them. Labradorites are fully represented, some polished pieces being over one foot across, and a number showing the beautiful chatoyant colors to perfection.

Amber, yellow, transparent, and containing flies and other insects, is present in the form of cut stones and beads.

A rich, dark-brown cut aragonite from California, and the beautiful green, copper-colored Smithsonite (a zinc-ore), from Laurium, Greece, demand special notice. One is a cut cabochon over one inch high, the other an ideal piece of the natural mineral. We observe also a fine polished malachite from Siberia, and a dish of the highly prized dark-blue fluorite from Derbyshire, England, where it is familiarly known as "blue John." Vases of this material have often been sold for over one thousand dollars. A slab of the Persian lapis-lazuli, and one of the white-veined variety from the Peruvian Andes, well represent this species. A jade pendant, three inches long and of good color, is one of the sort made in Germany to sell in New Zealand as genuine aboriginal workmanship. Also a flat vase made of a light-green Chinese jade, and one of the small bracelets of the same material, which are put on the arms of girls in early childhood, and allowed to remain there until the natural growth of the arm fixes them so tightly that they can not be removed over the hand. A rich yellow flower chiseled out of serpentine, about four inches by two, is very pretty, as is a curious, fanciful, dragon-like, talc ornament from Southern India. Red, white, and mottled agalmatolite (Chinese figure-stone), from China, is interesting.

One of the finest specimens of its kind in the United States is a magnificent six-by-four slab of lumachelle ("fire-marble") of fossil origin, in which the color of the original shells is so deepened and intensified that it rivals the finest fire-opal. This comes from the old, exhausted locality of Carinthia, Germany. Of alabaster, we have white, yellow, and cinnamon-gray slabs; of fossil coral, a fine slab from Iowa City. The oölite limestone from Bristol, England, is curious; the surface is highly polished, presenting a white field flecked with dark-red. Beads of gypsum satin spar and a three-inch egg of the same material are from Bideford, England.

The collection ends with an eight-by-three slab of catlinite (Indian pipe-stone), from Coteau du Prairie, Pipestone County, Minnesota. The head delineated on it was carved by a Washington sculptor, and came into the museum with the Abert collection, which was given to the museum.

To the energy of Professor F. W. Clarke is due the credit of forming this most interesting series of gems.

THE WHIPPING-POST.

By LEWIS HOCHHEIMER.

WHEN men, under the impetus of the indignation and horror that are occasioned by the commission of crimes that bear the stamp of deliberate cruelty or atrocity, undertake to apply what are popularly deemed adequately severe remedies, their action generally embodies results that, to the mind of those versed in matters of social or governmental science, are as mischievous in their tendency as the evils sought to be remedied. It not infrequently happens, in cases of crimes of deep atrocity, that citizens resolve to *avenge* the wrong immediately, by *lynching* the offender. The folly and wrong of this method of meting out punishment in a civilized community are now universally conceded by calm-thinking and intelligent men. Again, it will happen that this same spirit of impatience at the slow processes of law and of distrust in the ordinary legal methods of punishment for crime will find its expression in an equally wrong and illogical method, to wit, the adoption of *legislation* providing cruel methods of punishment for certain crimes, in the belief that the evil of their frequent perpetration may be remedied in that way. Upon reflection, it will be found that both methods have their origin in the same erroneous conception of the scope and object of *punishment for crime.*

Under the designation "cruel punishments," I include all such penalties for crimes as are designed to inflict direct physical suffering, accompanied by circumstances of ignominy. The whipping-post is an example. The infliction of such penalties proceeds upon the theory of *retaliation*, and, for this reason, is improper and vicious. The legitimate province of all laws relating to penalties for crime is *punishment* simply. Anything that is inflicted beyond this, whether *against* law, as by mob violence, or by *legislation*, as in the case of retaliatory punishments, exceeds the legitimate scope of penalties for crime. There may be *scriptural precedent* to the contrary, but we must not adopt as a divine precedent, applicable to all nations, those rules which were laid down for a particular people, in a remote and barbarous age. Many things that are faithless, treacherous, unnatural and cruel, find a seeming sanction and precedent in the Mosaic law. Punishment, in its proper acceptation, means the protection of society, as represented by the State, against the inroads of the individual upon its welfare, or, as it is called in criminal-law phrase, "the peace of the State." It is only when the encroachments of the individual upon the rights of others amount to a *public wrong* that they are punishable criminally, and then it is only the wrong to society, and not the sin, that is cognizable by the tribunals.

Looking, then, at punishment in that light—viewing it as designed merely to conserve the public welfare, "the peace, government, and dignity of the State," as it is technically expressed in every formal indictment for crime in Maryland—by what consideration should we be guided in determining the true policy to be pursued in the application of punishments? Surely, not the narrow one of (at all hazards) *suppressing* the particular crime. Crime can not be stamped out by any heroic methods of treatment. Sin and crime are inevitable conditions incident to our present state of social advancement, just as disease is a factor of our physical being. He would be deemed an unskillful physician who directed all his efforts toward the driving away of a particular malady without regard to the effect of his course of treatment upon the general system of the patient. A like want of skill in statesmanship is exhibited when the legislator proposes such a remedy as that enacted in Maryland for wife-beating, to wit, the whipping-post, without weighing the effect of the introduction of that sort of remedy upon the constitution of the body politic.

The arguments advanced in support of this legislation are as plausible and as apt to impress the popular mind as they are fallacious and illogical. The crime of the brutal wife-beater affords an excellent topic for declamation and invective, and people of generous, high impulse are very prone to yield their cooler judgment in such matters to specious rhetoric. The purpose of this paper is to discuss the question from a logical stand-point, free from all declamation or sentimentalism, in which the discussions of such questions too frequently abound.

Now, firstly, let it be borne in mind that, in the discussion of a question of punishment for crime, we deal with public interests. Mere satisfaction to the individual upon whom the crime is perpetrated is not to be considered, nor is the matter of the welfare of the offender to control our action in dealing with crime. Both interests must yield to that of the State, which is the injured party. The errors most frequently committed in forming a judgment as to the punishment due for any crime arise, on the one hand, from an excess of hostile feeling toward the offender, which obscures our view of the real end to be accomplished by his punishment, and, on the other hand, the opposite bent of letting sympathy and excess of kindly feeling shut out from our view the demands of public justice.

In traveling through the dark mazes of human frailty and crime, it would be difficult to find an object more seemingly devoid of every nobler human instinct than the cruel wife-beater, for whose offense a recent Maryland statute has revived the lash and whipping-post; unless, indeed, it be that loathsome specimen from the list of criminals, in whom humanity seems to have sunk to its lowest ebb, the cruel child-beater. But, let us proceed to answer the real question which the punishment of the wife-beater raises for solution. Does *society*, whose laws have been broken and must be vindicated, upon the whole, gain or does it lose by the method of punishment under discussion? Granted that the whipping-post will stamp out the crime of wife-beating in our midst, does the gain justify the price?

To illustrate my meaning clearly, I lay down the following proposition, which will not be gainsaid by any one versed in matters of social science. If, in the case of any given offense, no punishment to be meted out to the offender could be devised that would be *effective* in deterring others from committing the like offense, then the State could not rightfully punish at all, however heinous the offense. Why? Because, in the language of an eminent and conservative writer upon this subject, "the end of punishment is not by way of atonement or expiation of the crime committed, for that must be left to the just determination of a Supreme Being, but as a precaution against future offenses." Unless the punishment can be made effective for the conservation of the peace of the State, we are not justified in inflicting it. From this the further proposition follows, that the State may inflict no further or greater punishment than is absolutely necessary to attain that end, the protection of society. Do these interests require and are they advanced by the infliction of lashes upon wife-beaters?

It may safely be stated that a husband, before he beats his wife to the brutal extent that is contemplated by the statute authorizing lashes, has already sufficiently shown his evil character to warn his wife that he is no fit husband for her to dwell with and enable her to procure the separation to which the law entitles her. If this were done, all occasion for any such crime would be avoided, and the wife would be protected, and society protected. But, must a wife, simply because her husband is a brute, seek a divorce, and thus lose home and husband, and, moreover, deprive her children of their home and their father's support? Should the brute not rather be flogged and made to bear the punishment which is *his* due, instead of punishing his *wife* and *children* by a separation? These questions, which I have heard asked frequently, I shall endeavor to answer. A separation is a hard remedy. Through no fault on their part, the man's wife and children suffer bitterly. If the whipping-post could obviate all this, that would be an argument strongly in its favor; but what are the results of lashing the man? I will detail them. 1. You deprive him of his *citizenship* ban, and banish him. He can never return to the community in which he lived and face his former acquaintances. 2. All his usefulness as a member of society is destroyed. All the good that was ever in him is driven out. With every lash you sear his soul and instill hatred and bitterness that can never be effaced. He, thenceforth, becomes a hapless wanderer and an outcast, with no ties or aspirations in common with his fellow-men. 3. His wife is *divorced*, practically, without the benefit of a regular divorce. Why so? Because the man, after being lashed, will never again return to her. You may assuredly assume this. But that is not all. 4. His children, most innocently and undeservedly of all, will suffer keenly. Not only are they deprived of their father, who will leave home, and friends, and usefulness behind, but they will be spoken of and treated slightingly by their youthful companions as the children of the man who has been flogged, and the stain will cling to them until the grave has closed over their remains. The very things to be deprecated and avoided are thus brought about by the whipping-post. According to a natural though not just impulse of our human nature, the very wife whose husband has been flogged on her account will meet with a degree of scorn, however undeserved. The State has, in no case, the right thus practically to *destroy* a citizen.

Apart from all these considerations, the demoralizing effect and brutalizing tendency of a public lashing should alone operate to condemn such legislation. While wife-beating may be suppressed, such exhibitions as were witnessed in Baltimore recently sow seeds that will crop out in other directions and produce a harvest of crime. This is a natural law, well understood by students of penal science. No exhibition can have a worse tendency than the public treatment of a human being in a manner that ignores his claim to consideration as such. The recent exhibitions, as related in the local newspapers, of a sheriff walking through the streets of Baltimore, "jauntily dressed," in procession with his "staff," and reported as feeling in "elegant trim" for his job, windows being raised all along the route, women and children rushing to pavements and casements, were a sad commentary upon our "improved" laws. The fruits of those exhibitions will outweigh, in their evil, all the possible "reformation" hoped for from such legislation.

Another consideration is the following: No man, by *any* act of his, can forfeit or lose his human nature. We are all created in one image. The strictest or most intolerant (put it as you choose) creeds give a man until after death without repentance before consigning him to perdition everlasting. Here, however, the State shuts out a man from repentance, treats him as a brute who has *forfeited* all right to consideration as a man. For, when we inflict *ignominy*, we do all this. In doing this, in disgracing a being created in the image of God, we simply insult the great Being who has implanted his image and spirit in all of us. However far we may stray from grace, we can not, by our acts, divest ourselves of our human nature or forfeit our claim to consideration as human beings.

The advocates of cruel punishments ask, How can you cope with brutality and brutal men unless you treat such men after their own fashion? You must meet brutality with brutality, is their plea; you must adopt strong remedies for evils that will not yield to mild measures. It might be answered that such punishments do not fulfill their end, and the history of all times and the testimony of the most enlightened students of such questions in all countries might be appealed to in confirmation. When, under English law, two hundred different actions, "many of them," according to a great writer on criminal jurisprudence, "not deserving the name of offenses," were punishable by death, and offenders were whipped, scourged, pilloried, hanged, quartered and sometimes roasted alive, crime was not less frequent, nor were the laws violated with less ado than to-day. The very circumstance that whipping and similar punishments have had their day of trial and were abolished by a generation that witnessed the workings of the system in all its full-blown beauty, demonstrates its unsatisfactory character to the minds of those best acquainted with it. But I go further. Crime is inherent in our defective civilization, and you can't hurry up the march of civilization in any such patent way as lashing men. Criminal law is not a panacea to soften the human heart. Civilization has reached a certain height or state of development, and sin and crime are concomitants of that state. While crime must be punished, it can not be wiped out. Human nature is so constituted that men revolt at the deliberate infliction of pain upon a fellow-being, more so, indeed, than at any violence or brutality committed by the offender in the heat of passion. Any punishment that shocks the moral sense of a community, as all cruel punishments are calculated to do, falls short of its mark and fails signally to produce the general satisfaction always arising from the administration of wise punishments. Wife-beating is the outcome of a state of society that produces numerous evils of equal degree of which the general public, not acquainted with reformatory work among criminals, are entirely ignorant. Brutal as the offense is, brutality will not be suppressed, civilization will not be advanced one shade nor society benefited or protected by resort to retaliatory punishments. That kind of proceeding always defeats its own object.

SKETCH OF HUYGENS.

NO name in the history of science is associated with more material advance, or with advances in more various directions, than that of Huygens. To him we owe important improvements in the telescope, which in his time was a very crude instrument; the discovery of the first satellite of Saturn and of the nature of his ring; the accepted theory of the character of the surface of the moon; the undulatory theory of light, which had to wait till our day to be verified or even accepted; the theory of the pendulum and of the properties of the cycloidal curve; continuous fractions; with Newton, the determination of the shape of the earth; the knowledge of the properties of double refraction and polarization; many other discoveries of practical use or theoretical value; and a few ingenious speculations which have been used to lend attraction to some works of popular science.

Christian Huygens van Zuylichem was born at the Hague, April 14, 1629, and died June 8, 1695. He was the second son of Constantine Huygens, secretary and counselor of three successive Princes of Orange, who was also a distinguished Dutch poet and writer of Latin verses. His grandfather, too, was a secretary to the great William the Silent; and his elder brother Constantine, serving in the corresponding capacity, accompanied Prince William Henry to England, where he went, in 1688, to become King William III.

His earlier instruction was attended to by his father, who, remarking the signs of promise in him, taught him music, arithmetic, and geometry, and, when thirteen years old, mechanics. At fifteen, he was given an instructor in mathematics; at sixteen, he was sent to Leyden to study law under Vinnius; and he attended the University at Breda from 1646 to 1648. In these cities he enjoyed the instructions of the skilled geometricians, François Schooten and Jean Pell, and his first essays in that branch of mathematics were so fortunate as to attract the attention of Descartes, who wrote concerning it: "A little while ago Professor Schooten sent me a tract by the second son of M. de Zuylichem, touching a mathematical invention which he had sought out; yet he did not find in it what he was looking for (and this was not strange, for he was seeking what no one has ever yet found); but he went at it so straightway that I am sure he will become excellent in that science, in which I hardly ever see any one who knows anything." Huygens also had unbounded admiration for the great philosopher, but never enjoyed the privilege of meeting him.

The prediction of Descartes was very speedily fulfilled, for, within a few years after his graduation, having taken a short journey with Henry, Count of Nassau, Huygens began the series of labors and publications that have made his name immortal, with his theorems, in

1651, on the quadrature of the hyperbola, ellipse, and circle, following it with a criticism of Père Gregory de Saint Vincent's treatise on the same subject, and, three years afterward, with his discoveries on the magnitude of the circle (*de circuli magnitudine inventa nova*).

In 1655 he went to France, and received a degree in law from the Protestant Academy at Angers. Returning to Holland, he engaged with his brother in the manufacture of large lenses. With one of these, an objective of twelve feet focal distance, he discovered the first satellite of Saturn (the sixth in the order of distance), and announced the fact, after the manner of his time, in an anagram. It is said that, in the excitement attending his achievement, he engraved his anagram upon the glass itself by the aid of which the discovery was made. He afterward made glasses with one hundred, one hundred and seventy, and two hundred and ten feet of focal distance, which could not be inclosed in a telescopic tube on account of the swagging, to which so long an instrument would be subject, but for which he contrived a kind of framework support, while the observer stood at the focal point, eye-glass in hand. The necessity of using such cumbrous contrivances has happily been dispensed with by the introduction of reflecting telescopes.

In 1656, Huygens published, in Dutch, a memoir on the calculation of probabilities, for which Pascal and Fermat had prepared the way, and which was translated into Latin by his preceptor, Schooten, to be inserted as an appendix to his "Mathematical Exercises," in illustration of the usefulness of algebra. In the same year he invented the escapement of watches and clocks. Galileo had already recognized the synchronism of the motion of pendulums, and experimenters had begun to avail themselves of it in timing their observations; but they knew of no better way of using the pendulums than to employ a man to keep them in motion and count their vibrations. Huygens connected them with clock-work, very much as we now have them, and made the whole operation automatic.

In 1659, having constructed an objective of twenty-two feet focal distance, Huygens turned his attention to Saturn's ring, which Galileo had perceived but dimly, discovered its true character, calculated its elements, and predicted its temporary disappearancee in 1671; a prediction which his fellow-astronomers saw fulfilled twelve years after it was made, with great admiration for his genius. In his work, giving an account of these observations, "Systema Saturninum," he also described the nebula in Orion, and the bands of Jupiter and Mars, announced that the fixed stars had no perceptible diameter, and made known his device for measuring the apparent diameters of the planets, an incipient micrometer. He discovered but one of the satellites of Saturn, and did not seem to care to look for any other; for his enterprise in this direction was bound by the opinion he entertained that there was a relation between the number of planets and of satellites;

and there were already six planets—Mercury, Venus, Earth, Mars, Jupiter, and Saturn; and six satellites—one for the Earth, four for Jupiter, and one for Saturn. This fancy did not, however, prevent his afterward accepting Cassini's discovery of four other satellites of Saturn, and speculating from it upon the possibility of there being still others, either between some of those already discovered, or beyond the orbits of all.

Huygens, having now attained a very high and extensive reputation, visited France and England in 1660 and 1661. He explained his method of grinding lenses to the scientific men of England, and, finding them occupied with the recently introduced air-pump, took back with him the idea of that instrument when he returned to Holland, after two years, to develop it and improve upon it. Remarking in his experiments the close adherence of two plates of polished metal *in vacuo*, he conceived that it was due to the same cause as that which, operating at still closer quarters, produces cohesion. At about the same period he developed a rule for estimating the height of a place by the local pressure, and reciprocally, for calculating the pressure at a given place from its elevation above the sea. He was made a member of the Royal Society of London, and communicated to it the solution of the law of impact of bodies, at which Descartes had made an unsuccessful attempt. His own solution involved the laws of motion, and of action and reaction, in the main as they are now understood, and contained the germ of the law of the conservation of forces.

In 1665 he accepted an invitation from Colbert to go to Paris and reside in the Bibliothèque Royale. There he wrote his treatises on dioptrics and the law of percussion, in a literary style which won from Newton the remark that it more nearly approached the style of the ancients than that of any other modern author. Subsequently he composed the greatest of his works, the "Horologium Oscillatorium," which was published in 1673, and has been pronounced, with the exception of Newton's "Principia," the finest work on the exact sciences of the seventeenth century. In the dedication of this work to King Louis XIV, he revealed the dominant characteristic of his mind, making it the great object of all his researches to find out useful things, to promote the knowledge of nature, and add to the comforts of living. "I shall not waste any time, great king," he said, "in demonstrating to you the usefulness of these things, for my automatons (clocks) placed in your apartments will impress you every day with the regularity of their indications and the consequences they promise you in the progress of astronomy and navigation." The first chapter of this work was devoted to the description of pendulum-clocks; the second chapter embodied a study of the motion of a grave body moving along a given curve, in which was established the tautochronism of motion in a cycloid. In the third chapter, concerning the evolution and dimension of linear curves, was introduced the idea from which the author deduced the theory of evolutes. In the fourth chapter he determined the center of oscillation of a pendulum, and consequently the length of the simple isochronous pendulum ; and in the fifth chapter was estimated the measure of the centrifugal force in circular motion.

We next find Huygens devising the application of the spiral spring to clock-movements, and making pocket watches and sea chronometers possible, and then disputing for the priority of the invention with the Abbé Hautefeuille, "one of those schemers who begin everything and finish nothing."

Huygens turned his attention to the study of the properties of light and weight and of the magnet, and communicated his results to the French Academy and the Royal Society. His theory of light was the one which is now generally accepted after having slept for a hundred and fifty years. Double refraction attracted his attention, and he explained that it was occasioned by an ellipsoidal form given to the light-waves, while in ordinary refraction the waves were spherical. To account for gravity he accepted the Cartesian vortices, and supposed that those bodies which were too unwieldy to keep up with the motion of the outside circles were forced to fall back into the inner circles, where the motion was slower, thus approaching the center. Considering the phenomena of terrestrial gravity exhibited in the variations of the oscillations of the pendulum, he concluded that the earth was a spheroid and not a sphere. He accounted for magnetism in a paper which has never been published, by a theory that has not endured. He left France in 1681, some say on account of the Edict of Nantes, others because his health was bad and he needed a change. At home in Holland he constructed an automatic planetarium to represent the motions of the solar system, and in doing it discovered the theory of continuous fractions.

In the mean time a revolution was taking place in the world of mathematics, through the discovery of the differential calculus by Leibnitz, a philosopher who has said of his intercourse with Huygens, some ten years previous to this time (1672 and 1673), that it opened a new world to him and made him feel like another man. The use of the new method would have greatly facilitated the calculations Huygens was making, but he had become skilled in the old ways, imperfect as they were, and not always of universal application, and, being too old to change his method readily, continued to employ them. But, after a discussion of the merits of the new system in correspondence with Leibnitz, he came to a full appreciation of its value, which he expressed freely by saying that he observed "with surprise and admiration the extent and fruitfulness of that art ; on whatever side he turned, he discovered new uses for it ; and conceived it destined to infinite progress and speculation."

The "Cosmotheoros," or "Observer of the World," which was not published till after the death of Huygens, was chiefly a treatise on the habitability of other worlds than ours, and was marked by curious and ingenious speculations, of a character from which his other works were almost entirely free. In this work, after expressing his belief in the existence upon the planets of living bodies in no way inferior to those on the earth, he added: "What obliges me to believe also that there is a rational animal in the planets is that, if there is not, the earth would have too great advantages (while it is one of the smallest of the planets) and would be too much elevated in dignity (while it is neither the nearest to the sun nor the most distant from it) over the other planets, if it had an animal so much superior to all that they have. . . . Finally, is it reasonable to suppose that the heavenly bodies among which our earth occupies so modest a rank have been created only in order that we other little men may enjoy their light and contemplate their situation and motion?" He also gave some vivid pictures of the scenery of the heavens as observed from the different planets, paraphrases of which had wide circulation in an English work of popular astronomy of the last generation. In observing the moon he made a study of its mountains and plains, and, remarking that the latter were too rough to be lakes or oceans, concluded, what is now generally believed, that the moon has no bodies of water; also that it has no atmosphere—none at least that rises above the valleys.

At the beginning of the year 1695, Huygens lost his faculties—an affliction he had suffered once before while residing in Paris, but from which he had recovered after removal to his native land. This time the affliction was permanent, except for a few lucid intervals which he employed in making testamentary dispositions of his property, and in consigning the care of his manuscripts to his friends Bürcher de Volder and Bernard Fullen.

Like his illustrious contemporaries Descartes, Leibnitz, and Newton, Huygens was never married. He is described as having had a good figure, and been possessed of a noble and elevated character. He was affable and frank in his disposition, and gave a warm welcome to inquiring young men, whom he was always ready to direct in the way of discovery. It was thus that Leibnitz came to him and received the inspiration of which we have quoted the acknowledgment. Though qualified by birth and fortune to shine in society, and constrained to figure there for a part of his life, he preferred retreat, and passed all of his time that he could in the country, immersed in his studies and experiments.

EDITOR'S TABLE.

THE GLADSTONE-HUXLEY CONTROVERSY.

WE yield the considerable space in our present number which is necessary to complete the discussion between Mr. Gladstone and Professor Huxley as the chief parties, on the scientific status of the Pentateuch, in its claims to embody and anticipate in an extraordinary manner the great results of modern science. Mr. Gladstone argues that the statements made thousands of years ago in the book of Genesis in regard to the manner and order in which this earth and its living tribes were produced conform so remarkably to the grand results of modern scientific research as to form a powerful argument in favor of the divine inspiration of the old Jewish chronicles. Professor Huxley takes issue with this conclusion, maintaining that there is nothing like the wonderful agreement alleged, as sufficient to constitute a "plea for a revelation from God," but that, on the other hand, the disagreements between the two records are so great as to be irreconcilable.

This is an old and hard-contested controversy. At first, and for a long period, the Bible, as a paramount and infallible authority, became a powerful instrument in the hands of bigotry and intolerance for the repression of science. For a long time the facts of observation and the proofs of experiment were of but little weight before the authority of Scripture texts. But theologians at length discovered that this was untenable and indeed dangerous ground; as, to plant the Bible squarely in the pathway of advancing science, would be certain to destroy its influence. The lead at last had to be given to the truths of observation and experience, against which it was of no use any longer to quote Scripture. But then came the task of reconciling biblical statements with scientific truths, and for a long period an immense amount of ingenuity and learning was expended to show that the Bible is in perfect harmony with science, and that all its most striking and important results are to be found there, expressed or implied. But neither could this ground be maintained; and after generations of heated contest the great controversy gradually settled itself by the general acceptance of the principle that the Bible was not given to teach science, and is therefore not to be judged by scientific standards. Hence, the present discussion seems now rather anomalous—the revival of an antiquated subject—which derives its chief interest from the eminent character of the parties engaged in it. Mr. Gladstone is, however, an old man, and, though still in great force, he represents ideas and phases of thought upon this question that were far more absorbing and ascendant half a century ago than they are now.

EDUCATION IN POLITICS.

A CORRESPONDENT of the "New York Times" sums up the functions of the Superintendent of Public Instruction of the State of New York as follows:

> The duties imposed upon the office require a man of education and of positive parts to satisfactorily discharge them. The act of 1854, which created the office, defines its duties at considerable length. It gives this officer general superintendence of the public schools of the State. It requires him to visit them, to inquire into their management, and advise and direct in regard to their course of instruction and discipline. He apportions and distributes the public moneys appropriated by the State for the support of schools, examines the supplementary appointments made to all the districts by the School Commissioners, and sees to it that each district is

set apart its proportionate share, and that the same is expended by the trustees and paid by the supervisors of the towns according to law. He gives advice and direction to school officers, teachers, and inhabitants upon all questions arising under the school laws. He establishes rules and regulations concerning appeals, hears and decides all appeals involving school controversies, and his decision is final. He is charged with the general control and management of teachers' institutes in the various counties, is authorized to employ instructors for the institutes and to pay them, and to certify the accounts for expenses incurred by the School Commissioners in conducting the same. He is required to visit the institutes, and advise and direct concerning their proper management.

He makes appointments of State pupils to the institutions for the instruction of the deaf, dumb, and blind, and generally supervises the management of these institutions. He established rules and regulations concerning district-school libraries. He apportions among the counties the number of pupils in the State Normal School to which each is entitled. He has charge of the Indian Schools, employs local agents to superintend them, and gives directions in regard to the erection and repairs of their school-houses. He is an *ex-officio* member of the Board of Regents and chairman of the Committee on Teachers' Classes in the Academies. He is also an *ex-officio* member of the Board of Trustees of Cornell University, of Syracuse University, of the Idiot Asylum, and of the People's College, and chairman of the Executive Committee of the Albany State Normal School. He is also charged with the general supervision of the State Normal Schools at Brockport, Buffalo, Cortland, Fredonia, Geneseo, Oswego, and Potsdam. He receives and compiles the abstracts of the reports from all the school districts in the State. The salary of the Superintendent is five thousand dollars, and he has a deputy, and is allowed to employ a force of clerks, whose aggregate salaries shall not exceed nine thousand dollars a year.

This is a very extensive list of duties and responsibilities to be intrusted to any one functionary by the self-governing people of a great State, especially on a subject so extensive and important, and we may add so domestic and social, as that of education. One would think that an intelligent and independent community would be somewhat scrupulous about parting with the control of its children in the matter of instruction, and would prefer to attend to that matter themselves, rather than to be much superintended by any distant office-holder who happens to be thrust into the position where he can regulate the schools of the State. But the Superintendent of Public Instruction is the head engineer of that vast political machine which has come to supersede all private agency in the formation of the minds and characters of the young so far as it is possible for schools to do it. We say "political machine," because the great work of carrying on primary education in this country is being steadily and rapidly swallowed up in the gulf of politics. Indeed, the fundamental reasons given for the existence of our common-school system, and avowedly the sole reasons for which it can be maintained, are political. It is freely admitted that the State has no other warrant for taking in hand the instruction of the young than to shape them as citizens in accordance with the political system we have adopted. As a consequence, the business of administering education is becoming a prominent part of politics, and appointments in all the best-paid positions are being more and more determined by the common influences of political manipulation and intrigue. The influence of this state of things upon teachers who are now all government office-holders is a chapter of the subject that can not be here dealt with, but is full of interest. Our object is now simply to call attention to a conspicuous illustration of the control of partisan politics over our whole system of State instruction.

No intelligent person will deny that the general subject of education is one of great complexity and great difficulty, and that to control it wisely and improve its practical methods is a task requiring much ability, long and profound devotion to its fundamental questions, and a wide and varied experience in educational work. But very few men can be found combining the rare qualifications needed in a State Superintendent of Education; at the very best these qualifications can only be secured in a partial degree, but this makes it all the more necessary that no effort shall be spared to secure the best talent available for so responsible a trust. It is needless to say that this desirable object is impossible under the political *régime* into which our popular education has now passed. The superintendency of schools of the State of New York has become a foot-ball of partisan faction among the politicians of the New York Legislature. The former Superintendent resigned some weeks ago, to take a more profitable office; and the temporary incumbent of the place will vacate the office in April, to be succeeded by whomsoever the Legislature appoints. A crowd of applicants of all sorts are after the place, lobbying and intriguing in Albany by all the means that are necessary to secure "success" in the scramble for a desirable position. That a competent man will be appointed under these circumstances is virtually impossible, for no thoroughly competent and self-respecting man would enter the lists of competition under these circumstances. The appointee will win because he or his friends can beat all competition in the questionable arts by which politicians are influenced, and the result will be legitimate—a natural outcome of the system by which the instruction of the young has been brought under political and therefore, of course, under partisan control.

Another exemplification of the influence of politics upon education is seen in the "Blair Bill," which proposes that Congress shall make a gift of seventy-seven million dollars, to be divided among the States of the Union to help them maintain their schools. The success of the bill, as we write, is said to be uncertain; but, whether it pass or not, it has had so extensive a backing as to well illustrate the sort of influence which politicians would bring to bear upon education. The tendency to make education a charity, and to bring school-houses into the same category with poor-houses, is sufficiently strong; but this measure, by an audacious stretch of constitutional power, would give the stamp of nationality to the charity policy. The scheme proceeds upon the peculiarly American assumption that anything can be done with money, and that the Central Government has only to scatter millions enough and all the people will be educated. But the assumption is false: there are things which no amount of money can do, while the evils of its lavish distribution are not only palpable and certain, but may result in the absolute defeat of the object intended. That the distribution of this seventy-seven million largess among the States would be profoundly injurious to the interests of popular education does not admit of a doubt; and the American Congress would have to make the experiment but once more to paralyze and destroy the existing common-school system of the country. For, by the results of all experience and the very necessity of things, those who expect to be helped will depend upon help, and put forth less effort to help themselves. Whatever lessens the interest taken by parents and citizens in the working and character of the schools, whatever tends to diminish their direct responsibility in regard to them, and to weaken the sense of obligation to make sacrifices for the instruction of the young, strikes a demoralizing and deadly blow at the springs and incentives of all educational improvement. Our people have yet to learn that one of the highest benefits of a popular educational system is in training parents and citizens to the efficient discharge of their social duties, and a national policy which undermines these obligations can not be too strongly reprobated.

Our readers are reminded that one of the most important scientific papers that have appeared in "The Popular Science Monthly" since its establishment is that by Herbert Spencer, in the present number, on "The Factors of Organic Evolution." It is a popular paper, but it will demand close attention to appreciate its significance and its force. The biological questions discussed are fundamental in organic evolution, or the theory of descent with variations, and Mr. Spencer brings into clearness aspects of the subject upon which there has hitherto been much confusion of thought. His root question is as to the import and value of the principle of natural selection contributed by Mr. Darwin, and the decision of which must fix Mr. Darwin's permanent place in relation to the doctrine of evolution. The need of a thorough investigation here is shown, on the one hand, by the confessed unsettledness in regard to the limits of the doctrine of natural selection, and how far it is capable of accounting for evolution phenomena—an uncertainty shared prominently by Mr. Darwin himself; and, on the other hand, by the exaggerated and extravagant claims that have been made for this principle as being all there is of evolution, and that Mr. Darwin is, of course, its founder. No man was so capable of dealing with this subject as Herbert Spencer, and it will be a matter of general congratulation that he has seen fit to take it up in the interests of science and of justice. But, quite aside from all personal bearings of the discussion, it will be found of the highest interest as a study in the progress of modern biology.

Mrs. Rickoff describes in another place in this number an exhibition of hand-work made out of school by children of from five and six to fourteen years, and draws various suggestive conclusions from the experience. Among these is the following remark: "One of the noticeable features of the exhibition was an apparent decline in originality of invention and spontaneity of thought after the first year or two at school." The inference, of course, is that the school exerted an unfavorable influence upon the manual practice. This could not well be otherwise, as the ideal of the schools is mental cultivation by books, and not by the exercise of the active powers; and, as the schools are machines run by verbal methods and backed by old bookish superstitions, the child brought under their influence will very naturally and very quickly lose any interest it may have previously acquired in manual efforts. The two systems are antagonistic, and we do not believe it is possible to graft any thorough or valuable plan of technical study on our public schools as at present organized. The technical system must be independently developed, and will force its way through or over the narrow, unpractical system that now has the field.

LITERARY NOTICES.

An Introduction to the Study of Chemistry. By Ira Remsen, Professor of Chemistry in the Johns Hopkins University. American Science Series. New York: Henry Holt & Co. Pp. 387. Price, $1.40.

This is one of the cases in which the bare announcement of the author's name goes far to establish the character of his performance. Professor Remsen could make no other than an excellent book on the subject of chemistry. He is a master of the subject, thoroughly familiar with its latest developments, a clear thinker, and a lucid writer, and he has besides had much practical experience as a teacher of the science.

The method of Professor Remsen's work is thus distinctly presented by the author. He begins his preface by remarking: "In preparing this book I have endeavored to keep in mind the fact that it is intended for those who are beginning the study of chemistry. Instead of presenting a large number of facts, and thus overburdening the student's mind, I have presented a smaller number than is usual in elementary courses in chemistry; but I have been careful to select for treatment such substances and such phenomena as seemed to me best suited to give an insight into the nature of chemical action. Usually the mind is not allowed to dwell for any length of time upon any one thing, and thus to become really acquainted with it, but is hurried on and is soon bewildered in the effort to comprehend what is presented. I can not but believe that it is much better to dwell longer on a few subjects, provided these subjects are properly selected.

"The charge is frequently made that our elementary text-books on chemistry are not *scientific*, that is to say, that not enough stress is laid upon the relations which exist between the phenomena considered — the treatment is not systematic. The student is taught a little about oxygen, a little about hydrogen, a little about nitrogen, etc.; and then a little about potassium, a little about calcium, etc., and he is left simply to wonder whether there is any connection between the numerous facts offered for study. It must be acknowledged that there are serious difficulties in the way of a purely scientific treatment of chemistry, but I think that it is quite possible to treat the subject more scientifically than is customary, and thus to make it easier of comprehension to the student. I have made an effort in this direction in the book here offered to the public."

Professor Remsen's remark about the difficulty in the way of a purely scientific treatment of chemistry here applies, as we suppose, to the difficulty of presenting it to beginners in the study, and is, of course, true; but we have considerable doubt whether the difficulty is to be met by any attempt to make the work of the beginner more scientific. From the quality of his book we must infer that Professor Remsen's "beginner" is a pupil advanced to considerable maturity of mind, sufficient to deal with conceptions of some complexity and comprehensiveness. It is assumed that he enters the laboratory, goes to work himself, and has such strength of thought that a few examples would be sufficient to familiarize him with the established interpretations and principles of the science. But the real "difficulty" in the case, we think, is, that a stage of mental growth has been jumped when more elementary conceptions of the subject could have been assimilated, and some preparation afforded for that scientific treatment upon which the professor proposes to enter. The child is, in reality, already familiar with many chemical phenomena, as facts of observation and experience, although he does not know that they are chemistry. The more rational method seems to us to begin considerally further back, and occupy the pupil at first with a range of simpler observations and experiments that shall acquaint him to a certain degree with the properties of substances and their simpler reactions, without attempting to grasp principles that can be better handled at a later stage. This would imply, of course, a grading of the subject, and an introduction to it as a part of primary education.

Class-Interests: Their Relations to Each Other and to Government. A Study of Wrongs and Remedies to ascertain what the People should do for Themselves. By the author of "Conflict in Nature and Life" and "Reforms: their Difficulties and Possibilities." New York: D. Appleton & Co. Pp. 172. Price, $1.

However we may regard the conclusions of the anonymous author of the present book, one thing is to be said in his favor— his views have only been reached by deliberate and comprehensive study. His volume is, at any rate, not to be classed with those products of hasty speculation on social subjects which are now so abundant. He began well at the beginning of philosophical inquiry, by writing an original volume on those necessary conflicts and antagonisms in nature and life which put limits to what can be accomplished in the various spheres of action in which men are engaged. It was a most wholesome and needed investigation, and that it excited so little attention and interest is painful evidence of that shallowness of thought and foolish extravagance of expectation with which political and social subjects are treated in Legislatures and by the press. The author's book on "Reforms: their Difficulties and Possibilities," was an extension and application of the principles of the first treatise to immediate practical questions and measures which are occupying the general attention of the public. That discussion led to the present book on "Class-Interests," which, indeed, was originally intended to be published as a part of the volume on "Reforms," as a final application of his systematic views.

Nevertheless, the author's original studies in the antagonisms of things, and the limits to accomplishment which these antagonisms imply, seem to have been wholly insufficient to neutralize the bias of temperament or the power of preconceived convictions. He avows that the results of his studies bring him into "accord with wide-spread movements of thought and action in this country and in Europe"; and of these he refers, first and in particular, to "the amplification of government functions"—that is, he joins the swelling crowd of those who are looking for salvation from social evils to the politicians. For, say what we will, the fact remains that what we have actually to deal with as government is simply the men who have possession of political power, and, under our representative system, they are the selected and successful demagogues of the community. Our legislators, as a mass, who constitute the working power of government, are neither the wise men nor the good men of society, but men who are incompetent for their task—men without knowledge of the subjects upon which they are required to act, sordid and ambitious self-seekers, in short, office-holders and politicians who have beat all rivals. The "amplification of government functions" means, therefore, simply committing more and more the great interests of society to incompetent and untrustworthy hands. Our author condemns *laissez faire*, and makes the serious mistake, usual with the party of interference, of affirming that it is a "do-nothing" policy; whereas that is the only school we now have which aims to hold government to its supreme work of administering justice in society. But that great object is now so overlaid with added "functions" as to be buried out of sight and forgotten, so that those who demand that, first of all, government shall enforce it among citizens, are charged with being in favor of "doing nothing."

The present volume is profoundly sympathetic with the needs of the masses of the people, and it closes with a very valuable essay on moral education in our primary schools, which ought to be extensively read.

Problems in Philosophy. By John Bascom, author of "Science of Mind": "Growth and Grades of Intelligence." New York: G. P. Putnam's Sons. Pp. 222. Price, $1.50.

The more obscure and refractory problems in philosophy are here dealt with in a series of essays, each of quite moderate length. To the presumption, nowadays so strong, that such collections of articles are apt to originate in the idea of "gathering up everything, that nothing be lost," the author replies that in this case the work is essentially new, as but one essay, that on "Liberty," has appeared elsewhere, while that has been somewhat modified. The discussions have been kept within marked limits of brevity, the writer assures us, with the view of securing an explicit statement of a few fundamental principles, and to avoid the evils of excessive elaboration which are so incident to systematic treatises on philosophy.

Dr. Bascom has here reviewed a considerable number of the most knotty questions that have been held as at the foundation of philosophy, and that have for many ages exercised the ingenuity of speculative inquirers. Among the problems considered will be found "The Relativity of Knowledge," "Spontaneity and Causation," "Freedom of Will," "Consciousness and Space," "Universality of Law," "Being," and "Final Causes." The author seems to have but little sympathy with those who hold that the human mind is shut out from any final solution of these problems. He belongs to the intuitionalist school of metaphysics, which resists the efforts of the empirical or scientific party to set limits to knowledge and to the powers of the mind. In his essay on "The Relativity of Knowledge," while not at all denying the principle, he condemns the sweeping conclusions that many have been disposed to draw from it, saying, "Relativity as a self-evident and harmless assertion is made to stand for relativity as an extreme and destructive theory."

The character of the volume is thus intimated by the author: "While the discussions now offered touch very closely the points at issue between the empirical and the intuitive tendencies in philosophy, they are not conducted with any express conformity to either mode of inquiry. There is, in the consideration of these fundamental questions, a distinct recognition of the fact that the phenomena of mind can not find a rational substratum of thought within themselves as phenomena merely, and also a recognition of the fact that it is these very phenomena, and these only, that call for explanation. The effort has been, therefore, to bring appropriate ideas to the interpretation of mental facts, as broadly and fully contained in human experience."

Japanese Homes and their Surroundings. By Edward S. Morse. Boston: Ticknor & Co. Pp. 372, with Plates. Price, $5.

Professor Morse has achieved a just distinction as an accurate observer in various fields of natural history, whose precision and facility in relation commend the published results of his labors alike to the scientific constituency and to the general reading public. The former class have shown their esteem for him by choosing him to preside at the next meeting of the American Association. He has been for many years Director of the Peabody Academy of Sciences, at Salem, Massachusetts. He visited Japan in 1877 to study the marine fauna of the coast, and, removing there in 1878 with his family, remained nearly two years as Professor of Zoölogy in the Imperial University of Tokio. During this residence he varied his labors with studying the traces of primitive man on the islands and making notes of ethnological and general interest. He afterward made a third visit to the country for the sole purpose of qualifying himself for the preparation of this and other works upon it. Many books have been written about Japan; but few of them have been the result of such patient, careful observation as this. For it the author made several explorations from Yezo to Satsuma, bringing himself into personal communication with the people of all classes, making thorough examinations of their houses, and keeping a daily illustrated journal of all that he saw and all that happened to him. The illustrations in this volume are *fac simile* reproductions of the pen-and-ink drawings he then made. Of the usefulness of such work as he has done here, he expresses a view with which all students of anthropology and of history will concur, when he says he feels that it "has not been altogether in vain, as it may result in preserving many details of the Japanese house—some of them trivial, perhaps—which in a few decades of years may be difficult if not impossible to obtain. . . . Nothing can be of greater importance than the study of those nations and peoples who are passing through profound changes and readjustments as a result of their compulsory contact with the vigorous, selfish, and mercantile nations of the West." The same principle is applicable to all peoples not yet spoiled, and can not be applied too quickly. "If investigators and students would bear in mind the precept of Miyada"—who held it to be a solemn duty to learn any art or accomplishment that might be going out of the world, and then describe it so fully that it might be preserved to posterity—"and seize upon those features in social life—forms of etiquette, games, ceremonies, and other manners and customs—which are the first to change in any contact with alien races, a very important work would be accomplished for the future sociologist." There is much of a practical bearing to be learned from Japanese architecture and decoration; we have in fact acknowledged it by so readily adopting their styles, or awkwardly trying to imitate them. We may criticise the things we do not like in Japan, or any other country not our own, but we should bear in mind that there may be things among ourselves equally objectionable and liable to criticism. But, "in the study of another people one should if possible look through colorless glasses; though, if one is to err in this respect, it were better that his spectacles should be rose-colored than grimed with the smoke of prejudice. The student of ethnology as a matter of policy, if he can put himself in no more generous attitude, had better err in looking kindly and favorably at a people whose habits and customs he is about to study. It is human nature the world over to resist adverse criticism; and, where one is prowling about with his eyes darkened by the opaquest of uncorrected provincial glasses, he is repelled on all sides; nothing is accessible to him; he can rarely get more than a superficial glance at matters, whereas, if he tries honestly to seek out the better attributes of a people, he is not only welcome to proceed with any investigation he wishes to make; even customs and ways that appear offensive are fully revealed to him, knowing that he will not willfully distort and render more painful what is at the outset admitted on all hands to be bad." In this spirit, which should be applied to other studies as well as those of social customs, the author has endeavored to give an account of Japanese homes and their surroundings. He might have taken the huts of the poorest people or the houses of the wealthy, as his types, but has preferred to make his general descriptions relate to the homes of the middle classes, with occasional references to those of the higher and lower orders. We have already drawn upon the matter of the book for an article in our March number. Further than to refer to that article as a general indication of the way in which the subject is treated, we will say that in the book the various items of household management, rooms, furniture, utensils, tools, gateways, objects of art, etc., are treated in detail in sections, which are monographs in themselves, and adorned with real illustrations; and that we find here and there hints relative to comparative economy, æsthetics, and morals, that point the way to instructive thought.

The New Agriculture; or, The Waters led Captive. By A. N. Cole. New York: Anglers' Publishing Company, 252 Broadway. Pp. 224.

Mr. Cole describes in this volume a system of drainage and self-irrigation which he has devised and uses at his hill-side home in Allegany County, New York, from which he claims to have obtained astonishing results in an improved condition of the soil, independence of spring frosts and summer drought, and greatly increased yield and quality of crops. The system consists in constructing along the hill-side a series of parallel drains of considerable size, and of depth reaching to below the frost-line. The drains are filled with stones loosely thrown in, and covered with flat stones having above them material for sifting the solid matters from the water. Overflow drains are provided at suitable points for conveying any excess of water to the next lower drain in the series. These drains collect all the water from rain, snow, and dew deposited upon the land above them, and act as reservoirs to hold it till it is drawn out by the needs of the soil in the dry season. From the operation of his system Mr. Cole claims to have realized a fourfold increase of cereal crops, with corresponding improvement in size, flavor, and production of fruits and vegetables; absolute freedom from disease, especially from fungoid affections; security against spring and autumn frosts, with considerable prolongation of the season; the conversion of hard-pan into good soil; prevention of soil-washing; effectual security against drought; and the formation of springs. The plan as described is particularly applicable to hill-side land.

Price-List of Publications of the Smithsonian Institution, July, 1885. Washington: Government Printing-Office. Pp. 27.

This list includes only the publications of the Institution (1847 to 1885) which can be furnished at the prices named. The publications not mentioned are out of print. The titles are given as they occur in the order in which the works were originally published, classified according to their subjects, by authors, and according to the particular series to which they belong. We are informed that all gratuitous distribution to individuals has been discontinued; but the "Smithsonian Contributions" and "Miscellaneous Collections" are presented to public libraries containing 25,000 volumes, learned societies of the first class, and small public libraries, properly recommended, where a large district would be otherwise unsupplied.

INTERNATIONAL SCIENTIFIC SERIES. VOL. LIII.

THE MAMMALIA IN THEIR RELATION TO PRIMEVAL TIMES. By OSCAR SCHMIDT. New York: D. Appleton & Co. Pp. 308, with Fifty-one Woodcuts. Price, $1.50.

THIS is the last work of the venerable Professor of Zoölogy in the University of Strasburg, the news of his death having arrived since its publication. That there has been a great advance in recent years of our knowledge of the mammalia, especially in relation to primeval conditions, is well known, and Dr. Schmidt in this volume has very ably summarized the most important results of recent research in this field. He published, some years ago, a volume in this series entitled "Doctrine of Descent and Darwinism," which has met with much favor as a contribution to modern philosophical biology. The present book is on the same line of exposition, and is offered by the author as a supplement, rounding up the discussion, while, at the same time, it has the character of a separate treatise. The author says: "It will be found to contain proofs of the necessity, the truth, and the value of Darwinism as the foundation for the theory of descent within a limited field, and is brought down to the most recent times. Within these limits the work is complete in itself; for, although the student of natural history may have become acquainted with interesting fragments of the actual science, still the subject has not before been presented in so comprehensive a manner or in so convenient a form."

PROTECTION *versus* FREE-TRADE. The Scientific Validity and Economic Operation of Defensive Duties in the United States. By HENRY M. HOYT. New York: D. Appleton & Co. Pp. 435. Price, $2.

THE late official head of the Commonwealth of Pennsylvania, Governor Hoyt, has here elaborated a pretty solid book on the general subject of freedom and restriction in commerce. The author is a protectionist, and has written his volume in the interest of that party. Its tone is controversial and lively, whatever may be said of its arguments, and the adherents of the "Pennsylvania System" will be sure to get great comfort out of its perusal. Governor Hoyt is an antagonist of free trade, and, as free trade is grounded in the principles of political economy, Governor Hoyt is also the antagonist of political economy; that is, a large portion of his book is devoted to discrediting the "so-called science" of wealth. As we understand the Governor, he seems to think that, so far as men's exchanges of property are concerned, this world was made much too big. It should have been limited, if not to the boundaries of Pennsylvania, then certainly to the boundaries of the United States; and he thinks, too, our policy should be to correct this blunder in world-making by ignoring anything outside these national limits. His idea appears to be that foreign trade is not profitable, and that we can make more money by being shut in among ourselves and ignoring all other nations. The key to the philosophy of his book is found in its concluding words, which are these, given with the emphasis of italics: "*The nearer we come to organizing our* COMPETING *industries as if we were the only nation on the planet, the more we shall make and the more we shall have to divide among the makers.*" The reason why it is necessary to break down "political economy" and get it out of the way is thus sufficiently apparent.

THE RAISING AND MANAGEMENT OF POULTRY. Boston: Cupples, Upham & Co. Pp. 125.

THIS volume contains a phonographic report of the addresses and discussions that were had at two meetings of poultry experts, in connection with the series of Saturday Farmers Meetings, which were held in Boston May 7 and 14, 1885. The subjects specially considered pertain to the establishment of the best breeds; the qualities of each breed, as an egg and flesh producer; the care and profit of the stock; and the great and increasing value of the poultry interest to farmers and the country.

SCARLET FEVER, AND CERTAIN SUGGESTIONS FOR ITS TREATMENT. By T. GRISWOLD COMSTOCK, M. D., of St. Louis. Pp. 19.

THE author in this paper calls attention to certain therapeutical measures for the treatment of the disease, "which, if not entirely new to some of the profession, are but little used by many, and nevertheless are of great value."

Catholic Historical Researches. Quarterly. Edited by Rev. A. A. Lambing. January, 1886. Pittsburg. Pp. 40. Price, 25 cents a number, $1 a year.

This is a new naming, appropriate to the enlarged scope of the "Historical Researches in Western Pennsylvania, Principally Catholic," which the editor began in July, 1884. The publication is intended to contain matters relating to the past history of the Roman Catholic Church in this country; to chronicle the progress of Catholic historical inquiry, giving proceedings and papers of societies; to reproduce original historical documents, registers, letters, etc.; and to contain departments for brief historical notes, inquiries, and replies, with book reviews.

Evolution and Religion. By Henry Ward Beecher. New York: Fords, Howard, and Hulbert. Part I. Pp. 145. Price, 50 cents. Part II. Pp. 295. Price, $1.

"The universal physical fact of evolution, postulated as a theory of the divine method of creation," says Mr. Beecher, "is one which so naturally and simply fits many a puzzling lock, that it is gratefully seized by many who seem to themselves to have been shut out from hope and from the truth. For myself, while finding no need of changing my idea of the divine personality because of new light upon his mode of working, I have hailed the evolutionary philosophy with joy. Some of the applications of its principles to the line of development I have to reject; others, though not proved—and in the present state of scientific knowledge perhaps not even provable—I accept as probable; but the underlying truth, as a law of Nature (that is, a regular method of the divine action), I accept and use, and thank God for it." Mr. Beecher has learned that he has in fact been for fifty years, without knowing it, preaching a doctrine of evolution in its application to a spiritual growth, and now fervently believes that that doctrine is bringing "to the aid of religious truth, as set forth in the life and teachings of Jesus Christ, a new and powerful aid, fully in line with other marked developments of God's providence in his Word." For two years he has preached with specific application of this principle to practical aspects of Christian life. These discourses are incorporated in these two parts of a single work. In the first part are placed eight sermons, discussing the bearings of the evolutionary philosophy on some of the fundamental doctrines of the Christian faith—the divine nature, the question of human sinfulness, the inspiration of the Bible, the divine providence, and correlated subjects. The second part contains eighteen sermons, pointing out the specific application of those general principles, and showing the main lines along which Mr. Beecher believes "the main course of the old ship will largely be laid."

Introspective Insanity. By Allan McLane Hamilton, of New York. Pp. 8.

In this paper is given a study of a remarkable phase of morbid affections, known to the French as *folie du doute* and to the Germans as *Grubelsucht*, which varies in intensity from mere morbid nervousness or eccentricity to positive insanity. It is described as a condition of mind which is manifested by a morbid feeling of doubt and consequent indecision under the most ordinary circumstances, when both the doubt and indecision are unreasonable in the extreme, but the individual, under the mandate of an imperative conception, yields more or less to his disordered emotions. It appears under numerous aspects, some of which are illustrated by the relation of cases.

On the Development of Crystallization in the Igneous Rocks of Washoe, Nevada. By Arnold Hague and Joseph P. Iddings. Washington: Government Printing-Office. Pp. 44.

In studying the lavas from the Pacific coast volcanoes, the authors were struck with insensible gradations in the microstructure in the ground-mass of rocks of the same mineral composition from a purely glassy form to one wholly crystalline, and corresponding to a fine-grained granite-porphyry. They were convinced by the chain of microscopical evidence that the glassy and crystalline rocks were simply the extreme forms of the same magma. This pamphlet gives the account of the experiments and investigations.

Ericsson's Destroyer and Submarine Gun. By William H. Jaques, Lieutenant U. S. Navy. New York: G. P. Putnam's Sons. Pp. 48. Price, 50 cents.

In his paper on "the Monitors," published in a recent number of "The Century," Captain Ericsson made a reference to his application of submarine artillery to the Destroyer, a vessel of war partially armored to attack bows on at short range. In the present work an examination is made of the submarine gun and projectile to the carrying of which Captain Ericsson adapts the plan of his vessel; and the conclusion is reached that the inventor "is able to present to-day, as the product of his study, application, and mechanical skill, a type of weapon for submarine warfare well to the front in torpedo experiments."

The Evolution of Revelation. By James Morris Whiton, Ph. D. New York: G. P. Putnam's Sons. Pp. 34. Price, 25 cents.

This essay is declared in its sub-title to be a critique of conflicting opinions concerning the Old Testament. As against the popular conception of that revelation which God is conceived as having made in the Bible, that it is something directly "handed down" from a Divine Author, and therefore superior to the pretensions of criticism, the author maintains a conception which, while it regards revelation as divine, "views it as a growth within the world, an evolution, no less than humanity itself, and no less than man himself a work of God, while also a phenomenon of the orderly development of the world, and, as such, a legitimate object of scientific criticism."

Syllabus of Instruction in Biology, with References to Sources of Information. By Delos Fall, Albion College, Michigan. Pp. 24.

The Syllabus is intended to furnish a brief skeleton or abstract of all that is comprehended, in the catalogue of 1885, under the terms Biology, Systematic Zoölogy, and Physiological Botany—except that the botanical part is to be given in a supplementary syllabus. The work will consist of the examination of sixteen type-forms of animals, and a less number of plants, in the philosophical order of complexity of development. The student is expected to collect his own material where it is accessible, to study and observe the object itself, make notes of all he observes, make suitable drawings, and embody the knowledge thus obtained, and no other, in a written essay or statement.

Marlborough. By George Saintsbury. New York: D. Appleton & Co. Pp. 218. Price, 75 cents.

"Marlborough" is a volume of the series of "English Worthies," edited by Andrew Lang, of which the Messrs. Appleton are the American publishers. The series will consist of short lives of Englishmen of influence and distinction, past and present, in various walks of life. Each biography will be intrusted to a writer specially acquainted with the historical period in which his hero lived, and endowed with a sympathy with his subject. Of the present volume it is sufficient to say that it is a life of one of the most distinguished English soldiers, by a writer who is well known in the field of literary and biographical sketches.

Household Remedies for the Prevalent Disorders of the Human Organism. By Felix L. Oswald, M. D. New York: Fowler & Wells Co. Pp. 229.

Dr. Oswald is no stranger to the readers of the "Monthly"; he is rather as a familiar friend to them. And the doctrines which he lays down in "Household Remedies" are the same which he has enforced with so much vigor and point, and with such charming grace of style, in the health papers he has from time to time contributed to our pages. In fact, if we read right, some of these health papers — those which come under the head of "Remedies of Nature" —are the basis from which this book of "Household Remedies" has been constructed.

Fifth Annual Report of the State Mineralogist of California, for the Year ending May 15, 1885. Sacramento: State Office. Pp. 235, with Plans.

The report is mostly taken up with the account of the State minerological representation at the New Orleans Exhibition, to which the plans refer.

War and Peace. An Historical Novel. By Count Leon Tolstoi. New York: W. S. Gottsberger. Two volumes. Pp. 322 and 357.

This work will command attention on account of the fame of the author, who, after having for a considerable time held an important official position under the Emperor of Russia, retired from public life and turned his attention to literature. He is now one of the most prominent Russian writers. The story relates to that period of the Napoleonic wars, from 1805 to 1807, which preceded the Peace of Tilsit, and introduces as actors several of the prominent characters of the time. The present edition is a double translation, the story having been first translated from Russian into French by a Russian lady, and then into English by Clara Bell.

Manual of the Botany of the Rocky Mountain Region. By John M. Coulter. New York: Ivison, Blakeman, Taylor & Co. Pp. 480.

"West of the Mississippi Valley prairie region," says the author of this "Manual," "there are three well-defined floras: One is that of the Pacific slope; another is Mexican in character, extending from the Great Basin to Arizona, New Mexico, Western Texas, and southward into Mexico; the third is the Rocky Mountain region, extending eastward across the plains to the prairies." The first floral region is descriptively provided for in two volumes on the "Botany of California"; the botany of the Great Basin is described in works by Sereno Watson and Dr. Rothrock. The third region was imperfectly described in Professor Porter's "Synopsis of the Flora of Colorado," a first attempt, published about ten years ago. The present volume is an attempt to furnish a more adequate presentation of the subject than could be given at that time, and to provoke still further advance and improvement. The range it is intended to cover includes Colorado, Wyoming, Montana, Western Dakota, Western Nebraska, and Western Kansas. In it are also included the larger part of the contiguous flora, running into the western part of the Indian Territory, Northwestern Texas, Northern New Mexico and Arizona, and Eastern Utah and Idaho, for all except their own peculiar plants. In Utah the range is carried westward by the Uintah and Wahsatch Mountains, whose plants are intended to be included. This edition only claims to be a compilation, and an orderly arrangement and sifting of scattered material—an arrangement and sifting that were greatly needed, for much of the material was practically inaccessible.

Studies from the Biological Laboratory of Johns Hopkins University. Baltimore: Newell Martin, M. D., F. R. S., and W. K. Brooks, editors. Vol. iii, Nos. 1 to 4. Pp. 216, with Twelve Plates. Price per volume, $5. The price of single numbers varies with the size.

These studies, issued from time to time, contain the majority of the original scientific papers published by members of the Biological Department of the University. They will be grouped into volumes of about five hundred pages each. The numbers before us contain eleven papers, giving accounts of special researches into various facts of special structure and function. Among the papers of most general interest are those of Mr. W. H. Howell, on "The Origin of the Fibrin formed in the Coagulation of Blood," and of Mr. H. G. Beyer, "On the Action of Carbolic Acid, Atropia, and Convallaria on the Heart, with some Observations on the Influence of Oxygenated and Non-oxygenated Blood, and of Blood in Various Degrees of Dilution," both of which are in No. 2.

The Louisiana Purchase in its Influence upon the American System. By the Right Reverend C. F. Robertson, D. D. New York: G. P. Putnam's Sons. Pp. 42. Price, 50 cents.

This paper, by the Protestant Episcopal Bishop of Missouri, belongs to the series of the American Historical Association. The subject, as the author reviews it briefly, becomes a very broad one—much larger, probably, than most readers are at the beginning ready to suppose it to be. In the first place, the purchase was acknowledged to be extra-constitutional, but then no one, in Congress or out of it, could say anything about that matter while it was under settlement, for fear of giving France a pretext for withdrawing from the bargain. The acquisition of so large a territory in the Southwest disturbed the balance of the country, caused discontent in New England, and developed a spirit of secession. A connection is traced between some of the results of the purchase and the British blockade acts and our embargo laws. A great impetus was given to the movement of population westward. Miranda's scheme for overthrowing Spanish power in South America and Burr's conspiracy were fed by it. The Texan revolution followed in due time, leading to the consequences of annexation, the Mexican War, and the acquisition of California. From this came a vast accession of wealth, the beginning of the era of large fortunes, and an entire change in American ideas of life, with a vast increase in the sweep and scope of American policy. Parallel with the earlier stages of these events was the taking shape of the Monroe doctrine, involving, among its consequences, the Clayton-Bulwer Treaty, the nullification of the French schemes against Mexico, and the unsolved problems of the future respecting interoceanic transportation over the Isthmus. Other consequences which have resulted or are emerging, made possible by the acquisition of Louisiana, are hinted at, but not considered in detail; but enough is brought forward to show that the theme is one on which much might be written.

A History of German Literature. By W. Scherer. Translated by Mrs. F. C. Conybeare, and edited by F. Max Müller. New York: Charles Scribner's Sons. Two volumes. Pp. 401 and 425. Price, $3.50.

The author of this important history is recognized as an accomplished philologist and a competent literary critic, and as possessing at the same time the gift of attractive popular exposition, thus having the three most desirable qualities for his undertaking. The period embraced in its review begins with the earliest writings, and extends to the death of Goethe. The first chapter traces the roots of German nationality back to the period preceding the Aryan separation, and presents a picture of its intellectual condition at the time it became known to the Romans. The second chapter treats of the rise and development of the German hero-legends in the epoch of the migrations, and during the Merovingian period; the third chapter of the Mediæval Renaissance, the so-called Old High-German period of the Carlovingians and the Ottos. The succeeding four chapters are devoted to the classical period of the Middle High-German lyric and epic poetry, extending from about the eleventh to the middle of the fourteenth century. The next two chapters include the next three centuries, the period of transition from Middle High-German to New High-German, to which Luther's translation of the Bible belongs. The remaining four chapters are devoted to the period in which we live, beginning with the close of the Thirty Years' war, and give especial attention to the development of lyric and epic poetry, from Paul Gerhard to Goethe. The whole is supplemented by a full chronological table of authors and literary works and events, a bibliographical appendix, and an excellent index.

Men, Women, and Gods, and other Lectures. By Helen H. Gardener. With an Introduction by Colonel R. G. Ingersoll. New York: The Truth-Seeker Company. Pp. 158.

Besides a characteristic introduction by Colonel Ingersoll, this book contains three lectures. The first gives the title to the volume; the second is on "Vicarious Atonement"; the third is on "Historical Facts and Theological Fictions." The author speaks from the point of one who regards the teachings of the Bible and the doctrines and practices of the Church regarding women as all wrong, and as lying at the bottom of all the disabilities which she believes woman has suffered in Christian lands. The third lecture embodies replies to certain specific claims that have been made that the Church has contributed to the elevation of woman's life and status.

Mechanics and Faith. A Study of Spiritual Truth in Nature. By Charles Talbot Porter. New York: G. P. Putnam's Sons. Pp. 295. Price, $1.50.

The author, as the basis of his theory, regards matter to be force, manifested in endless diversity of application to our nature and wants. "Force, truth, beauty, and love," he says, "are the four spiritual realities which in their unity interpenetrate, if indeed they do not constitute, all material forms of being. These spiritual realities are revealed directly to the spirit of man, while the forms within which they are contained are made known to him through his physical organs of perception." It is through the recognition of these and correlated truths "that the mind becomes able to perceive the harmony that exists between reason and faith." The author has endeavored to reach these truths and to show this harmony by the aid, primarily, of mechanical science and the analogies which it affords.

Fourth Annual Report of the United States Geological Survey. 1882–'83. By J. W. Powell, Director. Washington: Government Printing-Office. Pp. 473, with Plates.

The operations of the survey have been extended over the eastern part of the United States, under the authority of a provision in the appropriation act of 1882–'83, requiring it to make a geological map of the United States. The general map is to be made on a scale of $\frac{1}{250000}$, or four miles to the square inch. Besides the general report of the progress of the work of the survey and the administrative reports of the heads of divisions (embracing geologic, paleontologic, and chemic work), the present volume contains papers on "Hawaiian Volcanoes," by Clarence Edward Dutton; "The Mining Geology of the Eureka District, Nevada," by J. S. Curtis; "Popular Fallacies regarding the Precious Metal Ore Deposits," by Albert Williams, Jr.; "The Fossil Ostreidæ of North America," by Dr. Charles A. White; and "A Geological Reconnaissance in Southern Oregon," by Israel C. Russell.

Social Wealth. The Sole Factors and Exact Ratios in its Acquirement and Apportionment. By J. K. Ingalls. New York: The Truth-Seeker Company. Pp. 320. Price, $1.

The professed purpose of this book is to direct inquiry to questions intimately related to all human life and employment. The author assumes that "we are living under a system of capitalistic aggrandizement or commercial monarchism," and that "our political *savants* offer us nothing but what is most delusive and contradictory, while servilely bowing to the demands of a dominant plutocracy." On the other hand, we have the ideas of the European radicals etc., "with suggestions of revolution and of measures of reform ranging from anarchism to the control of social industry by the state." He thinks there must be some natural relation between the worker and the soil, some principle of law which will give an equitable share of the products of industry to each who shares the labor, and a just principle of agreement and consent in regard to such production and division; and endeavors to discover these principles.

Mineral Resources of the United States, Calendar Years 1883 and 1884. By Albert Williams, Jr. Washington: Government Printing-Office. Pp. 1016. Price, 60 cents.

This volume is the second of the series. While it bears the same title, with the exception of the date, as the former volume which covered the calendar year 1882, it is not a reprint, or second edition of that report. The tables of production are re-given; but it has been the endeavor to avoid as far as possible a reproduction of the descriptive matter. While some of the main topics discussed in the former volume, concerning which nothing new has been brought out, are omitted, other subjects, which were not adequately discussed before, are now dealt with at considerable length. A considerable number of the articles appear as special contributions, with the authors' names attached.

The Greek Islands and Turkey after the War. By Henry M. Field, D. D. New York: Charles Scribner's Sons. Pp. 228. Price, $1.50.

The region of which this book gives the author's views of travel is not only one of the finest of the earth in its scenery, but is also predominantly rich in associations of profane and sacred history and literature and art, which are regarded by the majority of reading people with the warmest interest. It is also becoming the scene of stirring movements of progress and political reconstruction, and thereby a center of great contemporary interest. In describing it as a whole and in its different parts, Dr. Field has an eye to all these points of interest, and gives to each its due place. The book contains chapters on the Island of Cyprus; the shores of Asia Minor; the Archipelago; Smyrna; Mitylene and Troy; Constantinople and the American missions and schools; and the affairs and prospects of Turkey and the new states, with histories of the recent events that have led up to independence or autonomy of the latter.

Wonderful Escapes. From the French of F. Bernard, with Original Chapters added by Richard Whiting. New York: Charles Scribner's Sons. Pp. 306, with full-page Illustrations. Price, $1.

This is a volume of the "Illustrated Library of Wonders," of which the publishers are issuing a new and cheap edition. It relates, each story being complete in itself, a number of the most marvelous escapes of persons from extreme danger, of which history is full, beginning with the story of Aristomenes the Messenian, 684 B.C., as related by Pausanias, and closing with the escapes of Louis Napoleon from Ham, and James Stephens, the Fenian, from Richmond Prison. In it we find the narrative of the delivery of the twelve priests by Geoffroy Saint-Hilaire.

The Spartan and Theban Supremacies. By Charles Sankey. Pp. 231, with Maps. The Early Hanoverians. By Edward E. Morris. Pp. 235, with Maps and Plans. New York: Charles Scribner's Sons. Price, $1 each.

These volumes belong to the series of "Epochs of History," a series the purpose of which is to select and present in a separate volume, complete in itself, a group of events of such importance as to entitle it to be regarded as an epoch. In the selection of authors for the several volumes, regard has been had to the special qualifications of the writer for the portrayal of the particular period assigned to him. The former volume embraces that period—while the history of Greece was still substantially the history of the world—when Athens had failed to weld her discordant neighbor cities into something like national unity, and the experiment was about to be taken up by the ruder states of Sparta and Thebes in succession, to end in a common downfall under the heels of the Macedonian conqueror. Greece had still great men—the soldiers of Sparta and Thebes, and Socrates—but her time of usefulness was substantially over. This volume shows the progress and the speed of the decline.

The second volume is a logical continuation of the same author's "Age of Anne," and relates to a period which was lively in British politics, and was not without brilliant deeds in the wars of other countries. While the name of the epoch is taken from English history, some of the subjects—the Turkish wars, the War of the Polish Succession, Anson's voyage, and many minor matters—are not usually treated in our school-histories. One of the most acceptable features consists in the literary biographies, among the subjects of which are Leibnitz, Newton, the poets and novelists of the period, Dr. Johnson, Rousseau, and Voltaire. Biographies of the political characters are also given, and the account of the rising known as "the 'Forty-five" has been made very full.

Bulletins of the United States Geological Survey. Nos. 7 to 14, constituting Vol. II. Washington: Government Printing Office. Pp. 830, with Plates.

No. 7 is a catalogue of geological maps of America, North and South, from 1752 to 1881, containing 924 titles arranged in geographical and chronological order, by Jules Marcou and John Belknap Marcou; No. 8 is a paper "On Secondary Enlargements of Mineral Fragments in Certain Rocks," by R. D. Irving and C. R. Van Hise, in which something like a crystalline growth of minerals is indicated; No. 9 is "A Report of Work done in the Washington Laboratory during the Fiscal Year 1883, 1884," by F. W. Clarke and T. M. Chatard; No. 10 is "On the Cambrian Faunas of North America," relating particularly to the St. John formation, New Brunswick, and the Braintree Argillites, by C. D. Walcott; No. 11 is "On the Quaternary and Recent Mollusca of the Great Basin, with Descriptions of New Forms," by R. Ellsworth Call and C. K. Gilbert; No. 12 is "a Crystallographic Study of the Thinolite of Lake Lahontan," by Edward S. Dana; No. 13 is a sketch of the boundaries of the United States and of the several States and Territories, with an historical account of the territorial changes, by Henry Gannett; and No. 14 is a paper on the "Physical Characteristics of the Iron-carburets," etc., by Carl Barus and Vincent Strouhal. Except where special provision has been made, the United States Geological Survey has no copies of its publications for gratuitous distribution; but copies of most of its works are on sale at fair prices, the moneys resulting from which are, in accordance with an act of Congress, covered into the Treasury of the United States.

PUBLICATIONS RECEIVED.

A New Logical Machine. By Allan Marquand, Ph. D., Princeton, N. J. Pp. 5, with 1 late.

International Copyright. By an American. London: Ballantyne, Hanson & Co. Pp. 30.

Did Reis invent a Speaking Telephone? Opinons of Scientific Men. Pp. 18. On Telephone Systems. By Professor Amos E. Dolbear, Tufts College, Mass. Pp. 28.

Bulletin of the Buffalo Society of Natural Sciences, W. C. Barrett, M. D., Corresponding Secretary. Vol. V, No. 1. Pp. 46.

The Study of the Nahuatl Language. Pp. 7. Notes on the Mangue (extinct language). Pp. 22. By Daniel G. Brinton, M. D., Philadelphia.

Notes on the Flora of Eastern Virginia. By Lester F. Ward. Pp. 7.

Convention of the Provincial Educational Association of Nova Scotia. Minutes. A. McKay, Halifax, Secretary. Pp. 70.

The Scholar's Portfolio. Monthly. J. F. Sharp, Editor and Proprietor, Williamsport, Pa. Pp. 8. $1 a year.

Silver and Gold (Papers on Bimetallism). By F. J. Scott, Toledo, O. Pp. 28.

Bulletin of the Chemical Society of Washington. No. 1. A. C. Peale, Secretary. Pp. 28.

Veterinary Bulletin, Agricultural College of Michigan. Pp. 4.

A Few Suggestions for the Prevention of Fires. New York: Home Insurance Company. Pp. 8.

The Selborne Society for the Preservation of Birds, Plants, and Pleasant Places. London: G. A. Musgrave. Pp. 11.

Patriotism and National Defense. By Charles H. Hall, D. D. New York: Society for Political Education. Pp. 43. 25 cents.

Modern Armor for National Defense. By William H. Jaques, U. S. Navy. New York: G. P. Putnam's Sons. Pp. 44. 50 cents.

The Post-mortem Imbibition of Poisons. By George B. Miller, M. D. Pp. 8. The Exhalation of Ozone by Odorous Plants. By Drs. J. M. Anders and G. B. M. Miller. Pp. 8.

River and Harbor Improvement Convention at Tuscaloosa, Ala., November 17, 1885. Proceedings. W. C. Jemison, Tuscaloosa. Pp. 68.

The Lepers of Molokai. By Charles Warren Stoddard. Notre Dame, Ind.: "Ave Maria" Press. Pp. 80. 10 cents.

Letters from a Chimney Corner. Chicago: Fergus Printing Company. Pp. 50.

Education in Japan. Washington: Bureau of Education. Pp. 56.

A Theorem of Maximum Dissipativity; and A New Law of Thermo-Chemistry. By George F. Becker. Pp. 11.

Report of the Connecticut Agricultural Experiment Station for 1885. New Haven. Pp. 139.

Precious Stones. By George F. Kunz. Washington: Government Printing-Office. Pp. 60.

Bement Collection of Minerals, from Notes by Professor Gerhard von Rath. By George F. Kunz. New York. Pp. 11.

Report of the International Electrical Exhibition on Steam-Engines. Pp. 27, with Plates.

Report of the Pathological Department of Norristown Hospital for the Insane, Pennsylvania. Pp. 30.

Report of New York State Reformatory, Elmira. Pp. 46, with Plates.

On the Movement-Cure in China. By D. J. MacGowan, M. D. Pp. 12.

Report of New York Agricultural Experiment Station. Pp. 348.

Bulletin of the United States Geological Survey, Nos. 15 to 23, constituting Vol. III. Washington: Government Printing-Office. Pp. 497.

Evolution: A Scotch Verdict. By Charles F. Deems, LL. D. New York: John W. Lovell Company. Pp. 108. 20 cents.

Easy Lessons in Sanitary Science. By Joseph Wilson, M. D. Philadelphia: P. Blakiston, Son, & Co. Pp. 74. $1.

Our Own Set, a Novel. By Ossip Schubin. New York: William S. Gottsberger. Pp. 2-0.

Food Materials and their Adulterations. By Ellen H. Richards. Boston: Estes & Lauriat. Pp. 183.

The Chaldean Magician. By Ernst Eckstein. New York: William S. Gottsberger. Pp. 112.

Hobbes. By George Croom Robertson. Edinburgh and London: William Blackwood & Sons. Pp. 240.

Hospital Sisters and their Duties. By Eva C. E. Lückes. Philadelphia: P. Blakiston, Son, & Co. Pp. 164. $1.

Romish Teachings in the Protestant Churches. New York: N. Tibbals & Sons. Pp. 100. 90 cents.

The School-Room Chorus. Compiled by E. V. De Graff. 70th edition. Syracuse, N. Y.: C. W. Bardeen. Pp. 147. 35 cents.

The Adirondacks as a Health Resort. Edited by Joseph W. Stickler. New York: G. P. Putnam's Sons. Pp. 198. $1.

The Life and Genius of Goethe. Edited by F. B. Sanborn. Boston: Ticknor & Co. Pp. 454.

Evolution versus Involution. By Arze Z. Reed. New York: James Pott & Co. Pp 275. $2.50.

What Does History Teach? By John Stuart Blackie. New York: Charles Scribner's Sons. Pp. 123. 75 cents.

Where are We, and whither Tending? By the Rev. M. Harvey. Boston: Doyle & Whittle. Pp. 134. 75 cents.

Poetry as a Representative Art. By George Lansing Raymond. New York: G. P. Putnam's Sons. Pp. 346. $1.75.

An Apache Campaign in the Sierra Madre. By John G. Bourke. New York: Charles Scribner's Son's. Pp. 112. $1.

The Butterflies of the Eastern United States. By G. H. French. Philadelphia: J. B. Lippincott Co. Pp. 402. $2.

A Text-Book of Inorganic Chemistry. By Professor Victor von Richter. Translated by Edgar F. Smith. Philadelphia: P. Blakiston, Son, & Co. Pp. 432. $2.

Report of the Commissioner of Education, 1883–84. Washington: Government Printing-Office. Pp. 948.

Cassell's National Library. No. 1, My Ten Years' Imprisonment. By Silvio Pellico. Pp. 20?. No. 2, Childe Harold's Pilgrimage. By Lord Byron. Pp. 192. No. 3, Autobiography of Benjamin

Franklin. Pp. 192. No. 4. The Complete Angler. By Izaak Walton. Pp. 192. No. 5. The Man of Feeling. By Henry Mackenzie. Pp. 191. New York: Cassell & Co. 10 cents each.

Three Years of Arctic Service. By Adolphus W. Greely. New York: Charles Scribner's Sons. 2 vols. Pp. 428 and 444, with Maps and Plates. Sold by subscription.

The Fisheries and Fishery Industries of the United States. By George Brown Goode. Washington: Government Printing-Office. 2 vols. Pp. xx and 895, with 277 Plates.

POPULAR MISCELLANY.

The Study of American Languages.—Dr. D. G. Brinton has published an address, which he recently delivered before the Pennsylvania Historical Society, on the importance of studying American languages. Referring to the prominent place which is given to language in the study of ethnology, he shows that its study is particularly essential in the ethnology of America, for "language is almost our only clew to discover the kinship of those countless scattered hordes who roamed the forests of this broad continent." Through the aid of this study alone, Dr. Brinton says, we have already reached the positive knowledge that most of the area of South America, including the whole of the West Indies, was occupied by three great families of nations, not one of which had formed any important settlement on the northern continent. By similar evidence we know that the tribe which greeted Penn when he landed on the site of Philadelphia was a member of one vast family—the Algonquin stock—whose various clans extended from Carolina to Labrador, and from the easternmost cape of Newfoundland to the peaks of the Rocky Mountains, over 20° of latitude and 50° of longitude. We also know that the general trend of migration in the northern continent has been from north to south, and that this is true of the more nearly civilized as well as of the more savage tribes. But such external information is only a part of what these languages are capable of disclosing, for when rightly used they may reveal the inner life of the aborigine and the origin of his customs, laws, superstitions, and religions. Yet the number of those who are giving attention to the study of them is small. In Germany there are Von Tschudi, who has published a volume on the "Qquichua of Peru"; Dr. Stoll, who makes a specialty of the languages of Guatemala; Mr. Julius Platzmann; and Professor Friedrich Müller; in France, the Count de Charency, M. Lucien Adam, and a few other students; while Maisonneuve has published a commendable series of American grammars. In the United States we have the investigations of the Bureau of Ethnology; Dr. John Gilmary Shea, who began a "Library of American Linguistics"; Mr. Horatio Hale; Dr. J. Hammond Trumbull; Dr. Washington Matthews; the Abbé Cuoq, and others; all of whom have worked without reward or the hope of reward, without external stimulus, and almost without recognition. Dr. Brinton thinks that some of our colleges, learned societies, or patrons of science should offer inducements for this study, and asks the pertinent question, "Shall we have fellowships and professorships in abundance for the teaching of the dead languages and dead religions of another hemisphere, and not one for instruction in those tongues of our own land which live in a thousand proper names around us, whose words we repeat daily, and whose structure is as important to the philosophic study of speech as any of the dialects of Greece or India?"

The Southern Limits of Glacial Action.—Since Mr. H. Carvill Lewis described his tracing of the terminal glacial moraine across Pennsylvania, attention has been called by different observers to what appeared to them local evidences of glacial action in the region south of the line fixed by him. Eleven such spots have been particularly mentioned, one of which is as far south as West Philadelphia. Mr. Lewis has made personal examinations of all these places for the purpose of ascertaining whether the supposed evidences were real, and states, in the paper which he has published on the subject, as the result of his investigations, that he has found no reason to change his definition of the terminal line. In every instance he has found positive evidence of glacial action wanting, and that the marks relied upon by those who have supposed such action, in support of their views, can be amply accounted for as effects of water, or of atmospheric or other agencies than that of glacial ice. The gravel deposit at West Philadelphia, which Mr. C. E. Hall has regarded as a glacial moraine, "is identical with that which occurs all along the Delaware from Trenton to Wilmington." Even at the Wind Gap, only a short distance south of his moraine line, Mr. Lewis did not see a single scratched or transported bowlder, nor any striæ or other signs of glaciation, although these were abundant three miles away, where they suddenly stopped

Bacteria and Surgical Lesions.—The positive demonstration of the important factorage of bacterial growths in surgical lesions, says Dr. H. O. Marcy, of Boston, in an address before a section of the American Medical Association, would seem no longer wanting. Its recognition in the evolution of the systems of modern wound-treatment is apparent, yet Dr. Marcy is ready to admit that "many questions of great magnitude remain unsettled, that many subjects connected therewith are shrouded in doubt and obscurity, and that many fields of great promise remain yet for exploration. While this may temper our zeal, and cause us to examine with double caution our premises and conclusions, it can not the less stimulate every thoughtful student to better endeavor and renewed effort." The too commonly held ideas of antiseptic surgery, as consisting of carbolic acid applied as spray, or in dressing, are believed to be "not only superficial and misleading, but distinctly incorrect and injurious." Such imperfect knowledge of any scientific truths must have its fruitage only in evil, leading to a distrust in methods, at the best only half understood, and the results obtained, where protection in wounds has not been secured, are falsely reported in proof that antiseptic surgery is only the fashion of the hour."

Depth of Frozen Arctic Soil.—General Sir J. H. Lefroy communicated to the British Association at its last meeting the results, so far, of researches to ascertain the depth of the permanently frozen soil in the Arctic regions of Siberia and British North America. The depth of the "perpetual ground-ice," as it is called, has been found to be, near Yakutsk, Siberia, three hundred and eighty-two feet. But few actual measurements have been recorded in North America, for the people who possess a perpetually frozen soil do not like to speak of it, for fear that it may be regarded as a stigma against their climate. The greatest thickness of "ground-ice" yet actually measured in America is forty-five feet, as measured by Sir John Richardson in latitude 64° 20′ and longitude 124° 15′ west. There is good reason to believe, however, that within the Arctic Circle in America a thickness of ground-ice is attained much exceeding that at Yakutsk. Lieutenant P. H. Ray, U. S. A., sank a pit near Point Barrow, in 1883, to a depth of thirty-eight feet. At twenty-eight feet from the surface the temperature of the soil was 12° Fahr.; and it was the same at thirty-eight feet. Taking the unit of increase of temperature per unit of depth under-ground as 1° Fahr. for sixty-four feet, Lieutenant Ray provisionally computed the total thickness of the ice at about thirteen hundred feet. The depth to which the summer thaw reaches and its rate of progress are more variable, for they are more dependent on the season and the exposure than the depth of the frozen soil. They must greatly influence the agricultural capabilities of the place. In some respects the existence of a frozen stratum underground may be regarded as rather an advantage than otherwise. The cooling of the surface soil which it effects appears to be a provision to counteract the intense heating power of the sun in the summer months, and to secure a supply of moisture to the roots of cereals when they most require it; so much so that General Lefroy believes that agricultural experience in the Northwest would be in favor of retaining it, even if it were possible to get rid of it.

The Travels of a Storm.—At the meeting of the Royal Meteorological Society held November 18th, Mr. Henry Harries read a paper on "The Typhoon Origin of the Weather over the British Isles during the Second Half of October, 1885," which embodied the first daily tracing which has been made of a storm from the Pacific Ocean to Europe. The author showed by means of daily charts that a typhoon which originated near the Philippine Islands on September

27th passed over Japan and the Aleutian Archipelago, and entered the United States October 10th. Crossing the Rocky Mountain range, it proceeded through the Northern States and Canada to Labrador and Davis Strait. In the Atlantic it was joined on the 18th by another disturbance which had come up from the Atlantic tropics, the junction of the two being followed by a cessation of progressive movement from the 19th to the 25th. During this period a severe gale which passed along the southern counties of England on the morning of the 24th—a storm the forecasting of which was shown to be impossible—was formed. Following in the wake of this storm the parent cyclone reached the French coast on the 27th, its advent being marked by violent gales and extensive floods over the whole of Western and Central Europe and Algeria. Passing through France and the Netherlands, the disturbance showed signs of exhaustion, and on November 1st, in the Baltic, it quietly dispersed, after accomplishing a journey of more than sixteen thousand miles in thirty-six days.

Principles of Holiday Rest.—Writing about "The Misuse of Holidays," Dr. Andrew Wilson remarks that there is a wise method of spending our leisure time, as there is a foolish and body-wearing fashion of dealing with it. Rest, in the holiday sense, does not mean absolute inertness, but repose of the faculties, powers, and energies which are ordinarily exerted in our daily associations. It includes and makes allowance for the bringing into play of fresh muscles, new thoughts, and novel experiences of men, cities, sports, and surroundings at large. To the bringing into play of these new faculties, little used in our usual employments, is added the stimulus of the pure air and fresh scenery among which they are exerted. Hence we understand that holiday rest implies healthy activity of powers which, but for the opportunity it affords, would be apt to lie dormant and unused. In this view of the object of rest it would be a thorough mistake for a busy man not an invalid to bury himself in some dull resort where he will simply languish, without the slightest spark of interest being evoked by his surroundings. Equally erroneous is the ordinary hurried "tour," in which we go with a rush from place to place, gulping down novelties as we would bolt a ten-minute railroad-station dinner, without giving ourselves time adequately to digest anything and really enjoy it. Young people are apt to abuse their holidays by over-exerting themselves at some particular sport or exercise. "It is difficult to overdo exercise in the case of young and healthy people, but the walking tour may nevertheless be overdone, the cycling excursion may be of too extended a nature, and the yachting or boating may be fraught with just a little too much exposure to wind and weather." It is important that the place chosen for spending the holiday be suitable to personal wants and constitution. On these subjects every one has his own taste and his physical and psychical idiosyncrasies, and they should be regarded.

Symbolism of Architectural Ornament and Dancing-Girls.—M. Edmond Fuchs has remarked a connection between the peculiarities in the ornamentation of the ancient Cambodian architecture and the mythology of the builders. While the Egyptians and Greeks looked for their types of beauty in geometrical relations and numerical harmonies, the Indians sought them in the reproduction of living forms. In a balustrade they would represent a serpent stretching itself along perhaps hundreds of yards, with a row of broad-shouldered giants standing at intervals to support it. The form of the same serpent may be found carved on the pediment, its head jutting out at repeated intervals to mark the cornice. The walls of the monuments are covered with bas-reliefs representing theocratic symbols and incidents in the national history; and they are often pregnant with religious admonitions in the shape of representations of the punishments of hell. In the sacred inclosure of the Angkhor Wat, the Kmer sculptor has employed all his skill in depicting the refinements of the tortures to which guilty souls are condemned. A symbol occurring profusely, and which was imposed on the artists by the essential conditions of Oriental life, is that of the dancing-girl, a kind of hieratic character in Indo-China, whose function it was to perpetuate and interpret by her poses and mimicry the symbols and sacred legends of the ancient literature, the original myths which, having undergone a series of transformations, have gained a foothold in the popular conception and become fairy stories. The myths, the primitive forms of which are fixed by the dancing-girls in the Angkhor bas-reliefs, are the same as are represented in legendary form in the royal festivals, and as may be witnessed by any visitor at the palace of King Norodom I of Cambodia. While a choir of women chant the legends from the ancient sacred poems, other actors silently feign, in postures religiously prescribed by tradition, the emotions they are supposed to feel and the different phases of the drama represented. Thus, they interpret, by the same attitudes as were engraved upon the stone two thousand years ago, the myths and primitive beliefs that were vital in the imagination of the Aryans when they first entered the peninsula.

Effects of Cold on Microbes.—Mr. J. J. Coleman and Professor J. G. McKendrick have been making experiments on the effects of cold upon microphytes. With a mechanical freezer they produced a cold of 80° below zero, and lower, to which they exposed putrescible substances for various lengths of time; then the same substances were exposed to the conditions of temperature, etc., under which putrefaction is developed, and the results were observed. The experiments were made with meats, fresh and canned, wine, milk, beer, ale, meat-juice, neutralized vegetable infusions, putrefying fluids, gelatinous infusions of meat with grape-sugar, etc., in exposure to cold of from 80° to 120° below zero, for from a few hours to a hundred hours or more. The results were in every case substantially the same. The putrefactive process was checked and made slower for a time, but in no case were the micro-organisms so thoroughly destroyed but that putrefaction set in again after a greater or less length of exposure to a temperature favorable to it. The conclusion of the experimenters was that the degree of cold they employed may perhaps be competent to destroy living, developed organisms, but not to kill the germs. A cold-blooded animal —a frog—was frozen solid by a half-hour's exposure to a temperature of from −20° to −30°, but recovered on being thawed out, while after twenty minutes' exposure to −100° it failed to recover. A warm-blooded animal—a rabbit—was not frozen by an hour's exposure to −100°, but its bodily temperature became reduced from 99° to 43°.

Democracy in the High-School.—In a report on city schools, the late Mr. John D. Philbrick accounts for the rapid growth of public sentiment in favor of the high-school, which has not been confined to any one section of the country, by observing that these schools naturally find favor in a democratic community, because they are the most truly democratic of all our institutions. "Nothing is more common than to see pupils, representing the extremes in the social scale, sitting side by side in the high-school classes. I have seen the son of the cultured and wealthy merchant and the son of a very poor immigrant going together from the same class in the grammar-school to the same class in the high-school, the former spending his pocket-money to buy the requisite outfit of clothes and books for the latter. I have seen young ladies coming from families of the first rank, not only in respect to culture and wealth, but also in respect to ancestral pretensions, passing the three-years course in the girls' high-school side by side with the daughter of the laborer and the washer-woman. In a suburban town I have seen the daughter of a wealthy manufacturer procuring by subscription the funds to enable a classmate, the worthy son of a poor Irish farmer, to obtain the clothing needful to make it practicable for him to perform the part assigned him on graduating-day. At this same school on graduating-day I have heard the salutatory address by the daughter of an English immigrant laborer, who can neither read nor write, and the valedictory by the daughter of the wealthiest capitalist in town, while the most meritorious performance on the occasion was by a sister of the young man referred to. This young man, it may be added, who has been during the five or six years since his graduation most industriously at work on his father's little farm, is an ardent friend of the high-school, and he regards the 'idea that education unfits a man for manual labor as simply nonsensical.' The next neighbor to this young man's father is a man of the same nationality and in similar circumstances, who showed me with no little pride two silver medals which a son and a daughter, now working together in the same shoe-factory, obtained at the high-school. 'But,' said I, 'I have just been reading the writing of a man of learning and influence condemning the free high-school, and arguing that it should be abolished.' 'That man,' he replied, 'I consider an enemy to his country.'"

Two New Zealand Mountains.—Mr. J. H. Kerry Nicholls, while exploring the "King Country" of New Zealand, succeeded in ascending the tabooed volcano of Tongariso, which the Maoris consider it sacrilege to approach. The cluster of cones that marks it forms collectively an almost complete circle, rising from a level plateau about 3,000 feet above the sea; while the burning mountain itself, of wonderfully symmetrical proportions, rises from the bottom of an extensive basin-like depression in the very center of this great circle of cones and extinct craters. At 7,000 feet above the sea the traveler was able to look over the hot, quaking edge of the crater, which is circular, nearly a mile in circumference, and 400 feet deep. Within it was a smaller or inner crater, funnel-shaped, and separated from the larger one only by a narrow slip or ridge. At the bottom of the crater were scattered about huge rocky ridges, from the large fissures of which jets of steam burst forth with a roaring, screeching noise that echoed from the depths below with a wailing sound. "Hot springs sent up streams of boiling water, which, running over the rocks and losing themselves in the hot soil, were sent high into the air again in the form of coiling jets of vapor. Miniature cones of dark, smoking mud rose up in every direction, while around all was a seething fused mass of almost molten soil. In every direction were large deposits of pure yellow sulphur, some of which assumed a rock-like formation. At other places it formed a crust over the steaming earth, and when the thermal action was less intense the glittering yellow crystals covered the ground like a thick frost." From the top of the neighboring great mountain of Ruapehu, 9,250 feet above the sea, "a glorious sight burst upon the view. Peak rose above peak from the dazzling expanse of snow, each towering mass of rock, tinted of a reddish hue, standing out clearly defined against the light-blue sky. Immediately beneath where we stood was a steep precipice which fell perpendicularly for hundreds of feet below, and beneath this again was an enormous circle of jagged rocks marking the outline of a gigantic crater, filled to its brim with snow, which was furrowed into chasms of great depth." Adjoining this great mountain is the Onetapu Desert, or "desert of sacred sand," forming one of the most curious features of the region, which covers a large area of country. "In summer it is parched and dried, and gives life only to a few stunted Alpine plants; and, in the winter months, when the snows cover it, it is both difficult and dangerous to traverse. The desert at the surface is composed entirely of a deposit of scoria, with rounded stones and trachytic bowlders above, while in some places rise enormous lava-ridges. By its formations it would appear as if Ruapehu, when in a state of activity, had distributed its shower of ashes and lava over this wide region; and it would also appear that, at the period at which this extensive deposition of scoria occurred, there must have been growing upon this very spot an extensive forest; for as we rode over the dreary expanse we found the remains of enormous trees, which had béen converted into charcoal, as it were, at the time when the fiery ashes swept over them."

Protection against Malaria.—We have already noticed the discovery, by Professors Klebs and Tommasi-Crudelli, of the bacterial germ of malaria in the soil of the Roman Campagna. This discovery disposes of the chemical theories of the origin of malaria, and redeems marshes from the stigma of being its direct producers. There are, in fact, marshes where there is no malarial disease, and, on the other hand, disease rages where there are no marshes. The malarial germ, however, requires a certain degree of moisture for its development, and, as the marshes afford it, when marsh and bacteria are brought together, there is likely to be ague. The ancient inhabitants of the Campagna cleared it of disease by draining it so dry that the bacteria could not thrive in it. This is considered impracticable at present, and our Roman investigators have turned their attention to the best prophylactics against malarial poison. The universal quinine is good, but there are objections to its constant use, and arsenic, cautiously administered, is suggested as preferable. Professor Tommasi-Crudelli recommends, as an alternative prophylactic, decoction of lemon. The plantation of the eucalyptus appears to have failed. Near Rome, at the "Tre Fontane," where eucalyptus-trees have been grown with a special view to settling the question of their virtue, both the monks who inhabit the monastery and the workmen whom they employ have suffered as much as others. In one summer, when the Campagna was comparatively free from malaria, the inhabitants and servants of the "Tre Fontane" suffered more than the rest. Year before last, Professor Tommasi-Crudelli advised the Italian Government to drain and cover with turf the grounds of the Palazzo Salviati on the Lungara, where the new military college has been built. This was done. The result was that no cases of malarial fever occurred, while on the other side of the road there were several that ended fatally.

Inertia of the Eye and the Brain.—In a paper on the "Inertia of the Eye and the Brain," Mr. James McKeen Cattell, of the University of Leipsic, discusses, in view of the results of experiments which he has made, that part of the process of sensation which concerns the time a light must work on the retina in order that a sensation may be excited. The time is to a considerable extent dependent on the nature of the object and the intensity of the light. It varies with the several colors. Orange gives the quickest impression, and yellow is hardly behind it; next come blue, red, and green; while the retina is least sensitive to violet light, the time for which is from two to three times as long as for orange. When lamp-light is substituted for daylight, the time required for perceiving the colors becomes longer, and the order is changed to orange, red, yellow, violet, and blue. When the intensity of colored light varies, the time increases in arithmetical progression as the intensity decreases in geometrical progression. Applied to the distinction of words and letters, the experiments showed that Roman letters are more quickly perceived than German letters, and that the time is slightly shorter for words than for letters, but longer for long or rare words, and for words in a foreign language. The simplest geometrical forms of the letters seem the easiest to see; all ornaments on the letters hinder; and it is doubtful whether it is advantageous to use the thin lines or two varieties of letters in printing. Our punctuation-marks are hard to see, and Mr. Cattell, believing them to be useless, suggests that they might be replaced by spaces between the words proportionate to the importance of the pause. Some of the letters, as S and C, are hard to recognize in themselves; others, as O, Q, G, and C, are liable to confusion by their similarity of form; while E is "needlessly illegible." The order of distinctness for the small letters is d, k, m, g, h, b, p, w, u, l, j, t, v, z, r, o, f, n, a, x, y, e, i, g, c, s. The letters are slightly more difficult to grasp than the numbers, for every combination of numbers makes a number that gives "sense." Not as many words as letters can be grasped at one time, but three times as many letters, when they make words, and twice as many words when they make a sentence, as when they have no connection. The sentence is taken up as a whole; if it is not grasped, hardly any of the words are read; if it is grasped, the words appear very distinct; and this is also the case when the observer constructs an imaginary sentence from the traces he has taken up. The personal equations were important factors in all the experiments, but they did not materially affect the results as wholes.

The Problem of London Sewage.—The disposition of the sewage of London has been made the subject of the report of a royal commission, but still remains nearly as dark as ever. The one point on which all are agreed is that the present method of turning the sewage and rainfall of the streets into the river near the city is reprehensible from every point of view, but it is almost impossible to determine upon a method to be substituted for it. The commission have decided that the sewage had best be got rid of at the smallest cost compatible with efficiency. The suspended solid matters are the chief causes of nuisance: they may be almost entirely removed, and the tendency to the accumulation of deposits largely lessened, by precipitation; but the result of discharging an effluent alkalized by lime into the river at the present outfalls is problematical. Precipitation alone would not finally purify the river, but nuisances would still occur in dry weather, and the danger to fish and injury to wells would remain. The precipitation works themselves might be carried on without sensible nuisance at a cost of $1,000,000, or a shilling a head of the population per year, but practically a large part of the value of the sewage for manure would be lost. From two to six thousand acres of land would be required for the further purification of the sewage by being passed through it, after having been clarified with lime. The conclusion of the whole matter is, that while profit must not be expected from the utilization of sewage, yet precipitation and utilization are eminently fitted, when properly applied, to produce a purified effluent; and therefore, that, were certain conditions of population and of sewage always observed, each district could be made self-contained in respect of its sewage, just as it can be in respect of its cemetery. The condition as to population is that the district be limited in numbers and in the area occupied. The conditions as to the sewage are, the extent to which it can be separated from the rainfall, and the degree of freshness in which it is received at the place where it is treated.

A Formosan Sketch.—Mr. E. Colborne Baker, in the Royal Geographical Society, compared the shape of the Island of Formosa to that of a fish. If he likened it to a whale, he said, although he must confess it was not very like a whale, he might be asked to account for the blow-holes of the creature. Those blow-holes actually exist in the north part of the island, in the shape of sulphur pits and caverns, from which a great stream of sulphurous vapor is continually spouting in many parts. Her Britannic Majesty's consul at Tamsui resided within an easy morning's walk of an inactive volcano. The summit was a cradle four hundred yards in diameter, and ten miles off was a spot which was very much favored by the European inhabitants. There was a river of hot water, and not many yards off a cold waterfall. The river was fifteen yards broad and five or six feet deep, while the cold waterfall was fifty or sixty feet in height. The surrounding tract was of course burned ground, where no vegetation could exist; but a quarter of a mile away the flora was luxuriant, and the best pineapples in Formosa, which are the best in the world, were cultivated on the very margin of Avernus.

Mountain-Farming in Norway.—Farming in the mountain-regions of Norway is carried on under difficulties that would discourage an agriculturist bred on our prairies. The steep hills and rocks leave no broad spaces for fields, and the mountaineer, to winter his stock, has to make hay out of the grass that grows on the narrow ledges and in the crevices. If he manages to get a considerable crop off a hill, he will store it in sheds till winter, when he will send it down into the valley in bundles along a strong wire which he has stretched from the foot of the mountain to the top. To dry the hay, poles are planted near the patches, between which ropes or long sticks are laid till a sort of six-barred railing is formed. On these bars the hay is laid, and dried in a most effective manner. Corn is tied in small bundles and impaled on poles placed at intervals in the field. The potato-crop is farmed on a like small scale. The seeds are dropped here and there wherever there is a possibility of their taking root. At one place potatoes were noticed growing on a bowlder, where a soil about eighteen inches deep had gathered or been placed, the whole field being a triangle the sides of which were each about twelve feet in length. Small patches from twenty feet to as many yards square are common; while not unfrequently the corn-fields are but a name, for they meander like a stream in all directions among the huge bowlders and bare rocky hillocks which compose so great a part of the surface of a farm-land. The lands are usually very light. Manuring is not resorted to as a regular part of the routine. The fields are left from time to time for three or four years, by rotation, in grass. In the summer months, female servants, or the daughters of the farmer, tend the cattle high up in the *fjeld*, living in *sæters* or cabins, where they prepare cheese and butter. But this isolation of the young women is sometimes attended with serious moral disadvantages.

The Coral-Harvest.—The most productive coral-beds, which also yield the best and handsomest corals, are on the Algerian coast, and have been fished upon since the middle of the sixteenth century. Other beds are on the coasts of Sicily, Sardinia, Corsica, Spain, the Balearic Islands, and Provence. More than five hundred Italian vessels, with 4,200 men, are engaged in the coral-fishery, and collect annually 56,000 kilogrammes of coral, the value of which is calculated at 4,200,000 lire ($840,000). Besides these, 22,000 kilogrammes, worth 150,000 lire ($30,000), are collected in French, Spanish, and other boats, making the whole annual product 78,000 kilogrammes, and its value 5,750,000 lire ($1,150,000). The taxes which the Government exacts for the privilege of fishing on the African coast amount to 1,160 lire a boat in the summer and half as much in the winter, and this, taking into consideration the toil and danger of the fishery, reduces the profits to a quite modest rate. Estimating the gross returns per boat at 8,000 lire, and the cost at 6,033 lire, we have a net profit of 1,967 lire ($393.40). There are some sixty establishments in Italy where coral is worked up, forty of which are in Torre del Greco, and at which 9,200 hands, chiefly women and children, are employed. The principal markets for the coral are Germany, England, Russia, Austria, Hungary, and Poland; and considerable quantities are sent to Madras and Calcutta.

Advantages of Low Ceilings.—Rooms with low ceilings, or with ceilings even with the window-tops, are more readily and completely ventilated than those with high ceilings. The leakage of air which is always going on keeps all parts of the air in motion in such rooms, whereas if the ceiling is higher, only the lower part of the air is moved, and an inverted lake of foul and hot air is left floating in the space above the window-tops. To have the currents of fresh air circulating only in the lower parts of the room, while the upper portion of the air is left unaffected, is really the worst way of ventilating; for the stagnant atmospheric lake under the ceiling, although motionless, keeps actively at work under the law of the diffusion of gases, fouling the fresh currents circulating beneath it. With low ceilings and high windows no such accumulation of air is possible; for the whole height of the room is swept by the currents as the dust of the floor is swept with a broom. Low ceilings have also the advantage of enabling the room to be warmed with less expenditure of heat and less cost for fuel.

NOTES.

A mine of mercury—consisting of the sulphuret and chloride, with drops of metallic mercury, in a gangue of quartz—which appears to have been worked in ancient times, has been rediscovered at Schuppiastena, near Belgrade, in Servia.

Additional interest will be given to the coming meeting of the British Association at Birmingham, to be opened September 1st, by the exhibition of local manufactures which is to be held in connection with it. Similar exhibitions have been held on each of the three previous occasions when the Association met in Birmingham, in 1838, 1849, and 1865; and it is said that all of the international and other exhibitions which have since been held had their origin and prime model in the first of these; and that the Great International Exhibition of 1851 was suggested to Prince Albert by his visit to Birmingham in 1849. The coming exhibition will be more extensive and varied than any of the previous ones.

M. E. Rivière has discovered a new station or workshop of the neolithic age in the wood of Clamart, near the gates of Paris. He has recovered from it nearly nine hundred flints (from nodules in chalk), cut or broken by the hand, all of which lay on or near the surface of the ground. Among them are pieces of polished hatchets, scrapers (some very handsome ones), blades, points, and two or three little polishers.

Artificial lithographic stones are manufactured in Frankfort by M. Rosenthal from cement, which is put for the purpose through a course of very careful manipulations.

The Art Schools of the Metropolitan Museum are now established under the immediate supervision of Mr. John Ward Stimson, of the Paris School of Fine Arts, at 214 East Thirty-fourth Street. Eight courses in the fine arts, decorative work, and mechanical drawing are taught by as many instructors, at prices for tuition ranging from $10 to $15 per term (October 5, 1885, to May 1, 1886).

The Director of the Observatory of Harvard College, besides recording in his annual report the progress of the regular work of the observatory, describes the observations of Professor W. M. Davis and Mr. A. McAdie on the height and velocity of clouds. The observers, stationing themselves at different spots, and communicating by telephone, undertook to make simultaneous azimuth observations upon identical points in the clouds. About three hundred pairs of measures were made in the spring of 1885, with generally satisfactory results. The altitudes determined varied from 2,000 to 25,000 feet; for altitudes less than 8,000 feet the variation between the measures was generally within five per cent of the height. In one instance, cumulative observations of a single cumulus-cloud showed its base to be 4,500 feet high; its summit rose from the height of 6,750 to that of 7,300 feet at the rate of 200 feet a minute, while the cloud drifted to south 43° east at the rate of twenty-seven and a half miles an hour.

"Bowlder Mosaics" is what Professor J. E. Todd calls certain figures formed by piling bowlders which he has observed on some ridges in Dakota. One is a gigantic figure of a turtle about fifteen feet long. Another specimen is a figure of a snake, one hundred and twenty paces long, composed like the former of bowlders from four to six inches in diameter. "The eyes are much more expressive than it would at first seem possible to make them with such material. They have literally a 'stony' stare." Few similar figures have been seen elsewhere than at these two spots, but two cases are cited of structures showing geometrical designs. Rude sketches of animals on a smaller scale are also found near Pipestone, Minnesota, chipped or pecked on the smooth surface of the red quartzite. In these the turtle is a favorite figure. Similarly made figures, but quite imperfect, were noticed on Wolf Creek, southwest of Bridgewater, Dakota.

A special committee of the Prison Association of New York, appointed to examine the question of the best mode of employing convict-labor, has formulated its conclusions in resolutions which set forth that the highest test of excellence in any system of convict-labor is to be found in the adaptability of that system to promote the end of the convicts' reformation; that the contract system, in principle and in practical methods, is inconsistent with those forms of discipline and treatment that are most conducive to that object, and should therefore be condemned; that the best and most natural method is in the manufacture of supplies for use in institutions supported by the State, and in such other public work for use of the State as can be carried on in confinement; and that State prisoners should be employed on work of that kind, or, if it could not be provided for all, upon the piece-price plan.

In regard to the length of the range of vision, Mr. A. Shaw Page relates two instances in which he saw the Mourne Mountains of Ireland—which are 2,798 feet high—from Blackpool, England, one hundred and twenty-five miles away.

OBITUARY NOTES.

Mr. James Fergusson, an eminent English writer on historical and prehistorical architecture, died, January 9th, in his seventy-eighth year. He was a native of Ayr, in Scotland. He was best known by his "History of Architecture," which has gone through many editions, and is accepted as standard. He is remembered in archæology for the help he offered, in suggestions, etc., in the study of the rock-cut temples of India, and in explaining the meaning of Mr. Layard's discoveries at Nineveh, Schliemann's at Troy, Mycenæ, and Tiryns, and in the ideal restorations of the temples at Jerusalem and Ephesus, as well as by his books on "Rude Stone Monuments" and "Tree and Serpent Worship." He served his Government in 1857 as a member of the Royal Commission to inquire into the defenses of the United Kingdom; and in science he contributed a paper on "The Delta of the Ganges and the Natural Laws regulating the Course of Great Rivers."

M. de Saint-Venant, the "Dean" of the Mechanical Section of the French Academy of Sciences, died at Vendôme, on the 6th of January, in the ninetieth year of his age. He preserved his bodily vigor and working capacity till very near the time of his death.

The death is reported of Dr. Oscar Schmidt, Professor of Zoölogy in the University of Strasburg, and formerly occupant of the same chair at Cracow and Gratz, at the age of sixty-two. He was the author of the treatise on "The Doctrine of Descent and Darwinism," and of the recently published "The Mammalia in their Relation to Primeval Times," in the "International Scientific Series."

SUPPLEMENT.

DAWN OF CREATION AND OF WORSHIP.

REPLY TO DR. RÉVILLE.

By WILLIAM E. GLADSTONE.

AMONG recent works on the origin and history of religions by distinguished authors, a somewhat conspicuous place may be awarded to the "Prolégomènes de l'Histoire des Religions," by Dr. Réville, Professor in the College of France, and Hibbert Lecturer in 1884. The volume has been translated into English by Mr. Squire, and the translation * comes forth with all the advantage, and it is great, which can be conferred by an introduction from the pen of Professor Max Müller. It appears, if I may presume to speak of it, to be characterized, among other merits, by marked ingenuity and acuteness, breadth of field, great felicity of phrase, evident candor of intention, and abundant courtesy.

Whether its contents are properly placed as *prolegomena* may at once be questioned; for surely the proper office of *prolegomena* is to present preliminaries, and not results. Such is not, however, the aim of this work. It starts from assuming the subjective origin of all religions, which are viewed as so many answers to the call of a strong human appetite for that kind of food, and are examined as the several varieties of one and the same species. The conclusions of opposing inquirers, however, are not left to be confuted by a collection of facts and testimonies drawn from historical investigation, but are thrust out of the way beforehand in the preface (for, after all, *prolegomena* can be nothing but a less homely phrase for a preface). These inquirers are so many pretenders, who have obstructed the passage of the rightful heir to his throne, and they are to be put summarily out of the way, as disturbers of the public peace. The method pursued appears to be not to allow the facts and arguments to dispose of them, but to condemn them before the cause is heard. I do not know how to reconcile this method with Dr. Réville's declaration that he aims (p. vi) at proceeding in a "strictly scientific spirit." It might be held that such a spirit required the regular presentation of the evidence before the delivery of the verdict upon it. In any case I venture to observe that these are not truly *prolegomena*, but *epilegomena* to a History of Religions not yet placed before us.

The first enemy whom Dr. Réville dispatches is M. de Bonald, as the champion of the doctrine that "in the very beginning of the human race the creative power revealed to the first men by supernatural means the essential principles of religious truth," together with "language and even the art of writing" (pp. 35, 36).

In passing, Dr. Réville observes that "the religious schools, which maintain the truth of a primitive revelation, are guided by a very evident theological interest" (ibid.): the Protestant, to fortify the authority of the Bible; and the Roman Catholic, to prop the infallibility of the Church.

It is doubtless true that the doctrine of a primitive revelation tends to fortify the authority of religion. But is it not equally true, and equally obvious, that the denial of a primitive revelation tends to undermine it? and, if so, might it not be retorted upon the school of Dr. Réville that the schools which deny a primitive revelation are guided by a very evident anti-theological interest?

Against this antagonist Dr. Réville observes, *inter alia* (p. 37), that an appeal to the supernatural is *per se* inadmissible; that a divine revelation, containing the sublime doctrines of the purest inspiration, given to man at an age indefinitely remote, and in a state of "absolute ignorance," is "infinitely hard" to imagine; that it is not

* In his "Prolegomena to the History of Religions." My references throughout are to the translation by Mr. Squire (Williams & Norgate, 1884).

favored by analogy; and that it contradicts all that we know of prehistoric man (p. 40). Thus far it might perhaps be contended in reply, (1) that the preliminary objection to the supernatural is a pure *petitio principii*, and wholly repugnant to "scientific method"; (2) that it is not inconceivable that revelation might be indefinitely graduated, as well as human knowledge and condition; (3) that it is in no way repugnant to analogy, if the greatest master of analogy, Bishop Butler,* may be heard upon the subject; and (4) that our earliest information about the races from which we are least remote, Aryan, Semitic, Accadian, or Egyptian, offers no contradiction and no obstacle to the idea of their having received, or inherited, portions of some knowledge divinely revealed.

But I do not now enter upon these topics, as I have a more immediate and defined concern with the work of Dr. Réville.

It only came within the last few months to my knowledge that, at a period when my cares and labors of a distinct order were much too absorbing to allow of any attention to archæological history, Dr. Réville had done me the honor to select me as the representative of those writers who find warrant for the assertion of a primitive revelation in the testimony of the Holy Scriptures.

This is a distinction which I do not at all deserve: first, because Dr. Réville might have placed in the field champions much more competent and learned † than myself; secondly, because I have never attempted to give the proof of such a warrant. I have never written *ex professo* on the subject of it; but it is true that in a work published nearly thirty years ago, when destructive criticism was less advanced than it now is, I assumed it as a thing generally received, at least in this country. Upon some of the points, which group themselves round that assumption, my views, like those of many other inquirers, have been stated more crudely at an early, and more maturely at more than one later period. I admit that variation or development imposes a hardship upon critics, notwithstanding all their desire to be just; especially, may I say, upon such critics as, traversing ground of almost boundless extent, can hardly, except in the rarest cases, be minutely and closely acquainted with every portion of it.

I also admit to Dr. Réville, and indeed I contend by his side, that in an historical inquiry the authority of Scripture can not be alleged in proof of the existence of a primitive revelation. So to allege it is a preliminary assumption of the supernatural, and is in my view a manifest departure from the laws of "scientific" procedure: as palpable a departure, may I venture to say? as that preliminary exclusion of the supernatural which I have already presumed to notice. My own offense, if it be one, was of another character; and was committed in the early days of Homeric study, when my eyes perhaps were dazzled with the amazing richness and variety of the results which reward all close investigation of the text of Homer, so that objects were blurred for a time in my view, which soon came to stand more clear before me.

I had better perhaps state at once what my contention really is. It is, first, that many important pictures drawn, and indications given, in the Homeric poems supply evidence that can not be confuted not only of an ideal but of an historical relationship to the Hebrew traditions, (1) and mainly, as they are recorded in the Book of Genesis; (2) as less authentically to be gathered from the later Hebrew learning; and (3) as illustrated from extraneous sources. Secondly, any attempt to expound the Olympian mythology of Homer by simple reference to a solar theory, or even to Nature-worship in a larger sense, is simply a plea for a verdict against the evidence. It is also true that I have an unshaken belief in a Divine Revelation, not resting on assumption, but made obligatory upon me by reason. But I hold the last of these convictions entirely apart from the others, and I derived the first and second not from preconception, of which I had not a grain, but from the poems themselves, as purely as I derived my knowledge of the Peloponnesian War from Thucydides or his interpreters.

The great importance of this contention I do not deny. I have produced in its favor

* "Analogy," part ii, chap. ii, § 2.

† I will only name one of the most recent, Dr. Reusch, the author of "Bibel und Natur" (Bonn, 1876).

a great mass of evidence, which, as far as I have seen, there has been no serious endeavor, if indeed any endeavor, to repel. Dr. Réville observes that my views have been subjected to "very profound criticism" by Sir G. Cox in his learned work on Aryan mythology (p. 41). That is indeed a very able criticism; but it is addressed entirely to the statements of my earliest Homeric work.* Now, apart from the question whether those statements have been rightly understood (which I can not admit), that which he attacks is beyond and outside of the proposition which I have given above. Sir G. Cox has not attempted to decide the question whether there was a primitive revelation, or whether it may be traced in Homer. And I may say that I am myself so little satisfied with the precise form in which my general conclusions were originally clothed that I have not reprinted and shall not reprint the work, which has become very rare, only appearing now and then in some catalogue, and at a high price. When there are representatives living and awake, why disturb the ashes of the dead? In later works, reaching from 1865 to 1875, † I have confessed to the modification of my results, and have stated the case in terms which appear to me, using the common phrase, to be those yielded by the legitimate study of comparative religion. But why should those, who think it a sound method of comparative religion to match together the Vedas, the Norse legends, and the Egyptian remains, think it to be no process of comparative religion to bring together, not vaguely and loosely, but in searching detail, certain traditions of the Book of Genesis and those recorded in the Homeric poems, and to argue that their resemblances may afford proof of a common origin, without any anticipatory assumption as to what that origin may be?

It will hardly excite surprise, after what has now been written, when I say I am unable to accept as mine any one of the propositions which Dr. Réville (pp. 41, 42) affiliates to me. (1) I do not hold that there was a "systematic" or willful corruption of a primitive religion. (2) I do not hold that all the mythologies are due to any such corruption systematic or otherwise. (3) I do not hold that no part of them sprang out of the deification of natural facts. (4) I do not hold that the ideas conveyed in the Book of Genesis, or in any Hebrew tradition, were developed in the form of dogma, as is said by Sir G. Cox,* or in "six great doctrines" as is conceived by Dr. Réville; and (5) I am so far from ever having held that there was a "primitive orthodoxy" revealed to the first men (p. 43) that I have carefully from the first referred not to developed doctrine, but to rudimentary indications of what are now developed and established truths. So that, although Dr. Réville asks me for proof, I decline to supply proofs of what I disbelieve. What I have supplied proofs of is the appearance in the Poems of a number of traits, incongruous in various degrees with their immediate environment, but having such marked and characteristic resemblances to the Hebrew tradition as to require of us, in the character of rational inquirers, the admission of a common origin, just as the markings, which we sometimes notice upon the coats of horses and donkeys, are held to require the admission of their relationship to the zebra.

It thus appears that Dr. Réville has discharged his pistol in the air, for my Homeric propositions involve no assumption as to a revelation contained in the Book of Genesis, while he has not *ex professo* contested my statements of an historical relationship between some traditions of that book and those of the Homeric poems. But I will now briefly examine (1) the manner in which Dr. Réville handles the Book of Genesis, and (2) the manner in which he undertakes, by way of specimen, to construe the mythology of Homer, and enlist it, by comparison, in the support of his system of interpretation. And first with the first-named of these two subjects.

Entering a protest against assigning to the Book "a dictatorial authority," that is, I presume, against its containing a Divine

* "Studies on Homer and the Homeric Age," 3 vols. Oxford, 1858.

† "Address to the University of Edinburgh" (Murray, 1865); "Juventus Mundi" (Macmillan, 1868); "Primer of Homer (Macmillan, 1878); especially see Preface to "Juventus Mundi," p. 1.

* "Aryan Mythology," vol. i, p. 15.

revelation to anybody, he passes on to examine its contents. It contains, he says, scientific errors, of which (p. 42, *n.*) he specifies three. His charges are that (1) it speaks of the heaven as a solid vault; (2) it places the creation of the stars after that of the earth, and so places them solely for its use; (3) it introduces the vegetable kingdom before that kingdom could be subjected to the action of solar light. All these condemnations are quietly enunciated in a note, as if they were subject to no dispute. Let us see.

As to the first: if our scholars are right in their judgment, just made known to the world by the recent revision of the Old Testament, the "firmament" is, in the Hebrew original,* *not* a solid vault, but an expanse. As to the second (*a*), it is *not* said in the sacred text that the stars were made solely for the use of the earth; (*b*) it is true that no other use is mentioned. But we must here inquire what was the purpose of the narrative? Not to rear cosmic philosophers, but to furnish ordinary men with some idea of what the Creator had done in the way of providing for them a home and giving them a place in nature. The advantage afforded by the stars to them is named alone, they having no interest in any other purpose for which the stars may exist.

The assertion that the stars are stated to have been "created" after the earth is more serious. But here it becomes necessary first of all to notice the recital in this part of the indictment. In the language of Dr. Réville, the Book speaks of the creation of the stars after the formation of the earth. Now, curiously enough, the Book says nothing either of the "formation" of the earth, or of the "creation" of the stars. It says in its first line that "in the beginning God created the heaven and the earth." It says further on,† "He made the stars also." Can it be urged that this is a fanciful distinction between creating on the one hand and making, forming, or fashioning on the other? Dante did not think so, for, speaking of the Divine Will, he says:

"Ciò ch' Ella cria, e che Natura face." ‡

* The στερέωμα of the Septuagint is construed in conformity with the Hebrew.

† Gen. i, 16.

‡ "Paradiso," iii, 87.

Luther did not think so, for he uses *schuf* in the first verse, and *machte* in the sixteenth. The English translators and their revisers did not think so, for they use the words "created" and "made" in the two passages respectively. The main question, however, is, What did the author of the Book think, and what did he intend to convey? The LXX drew no distinction, probably for the simple reason that, as the idea of creation proper was not familiar to the Greeks, their language conveyed no word better than *poiein* to express it, which is also the proper word for fashioning or making. But the Hebrew, it seems, had the distinction, and by the writer of Genesis i it has been strictly, to Dr. Réville I might also say scientifically, followed. He uses the word "created" on the three grand occasions (1) of the beginning of the mighty work (v. 1); (2) of the beginning of animal life (v. 21), "And God created great whales," and every living creature that peoples the waters; (3) of the yet more important beginning of rational and spiritual life; "so God created man in his own image" (v. 27). In every other instance, the simple command is recited, or a word implying less than creation is employed.

From this very marked mode of use, it is surely plain that a marked distinction of sense was intended by the sacred writer. I will not attempt a definition of the distinction further than this, that the one phrase points more to calling into a separate or individual existence, the other more to shaping and fashioning the conditions of that existence; the one to *quid*, the other to *quale*. Our Earth, created in v. 1, undergoes structural change, different arrangement of material, in v. 9. After this, and in the fourth day, comes not the original creation, but the location in the firmament, of the sun and the moon. Of their "creation" nothing particular has been said; for no use, palpable to man, was associated with it before their perfect equipment. Does it not seem allowable to suppose that in the "heavens" *

* In our translation, and in the recent revision, the singular is used. But we are assured that the Hebrew word is plural (Bishop of Winchester on Genesis i, 1, in the Speaker's Bible). If so taken, we have the creation, visible to us, treated conjointly in verses 1–5, distributively in verses 6–19; surely a most orderly arrangement.

(v. 1), of which after the first outset we hear no more, were included the heavenly bodies? In any case what is afterward conveyed is not the calling into existence of the sun and moon, but the assignment to them of a certain place and orbit respectively, with a light-giving power. Is there the smallest inconsistency in a statement which places the emergence of our land, and its separation from the sea, and the commencement of vegetable life, before the final and full concentration of light upon the sun, and its reflection on the moon and the planets? In the gradual severance of other elements, would not the severance of the luminous body, or force, be gradual also? And why, let me ask of Dr. Réville, as there would plainly be light diffused before there was light concentrated, why may not that light diffused have been sufficient for the purposes of vegetation? There was soil, there was atmosphere, there was moisture, there was light. What more could be required? Need we go beyond our constant experience to be aware that the process of vegetation, though it may be suspended, is not arrested, when, through the presence of cloud and vapor, the sun's globe becomes to us invisible? The same observations apply to the light of the planets; while, as to the other stars, such as were then perceptible to the human eye, we know nothing. The planets, being luminous bodies only through the action of the sun, could not be luminous until such a degree of light, or of light-force, was accumulated upon or in the sun as to make them luminous, instead of being

"Silent as the moon,
When she deserts the night
Hid in her vacant interlunar cave." *

Is it not, then, the fact, thus far, that the impeachment of the Book has fallen to the ground? There remains to add only one remark, the propriety of which is, I think, indisputable. Easy comprehension and impressive force are the objects to be aimed at in a composition at once popular and summary; but these can not always be had without some departure from accurate classification and the order of minute detail. It seems much more easy to justify the language of the opening verses of Genesis than, for example, the convenient usage by which we affirm that the sun rises, or mounts above the horizon, and sets, or descends below it, when we know perfectly well that he does neither the one nor the other. As to the third charge of scientific error, that the vegetable kingdom appeared before it could be subjected to the action of solar light, it has been virtually disposed of. If the light now appropriated to the sun alone was gradually gathering toward and round him, why may it not have performed its proper office in contributing to vegetation when once the necessary degree of severance between solid and fluid, between wet and dry, had been effected? And this is just what had been described in the formation of the firmament, and the separation of land from sea.

More singular still seems to be the next observation offered by Dr. Réville in his compound labor to satisfy his readers, first, that there is no revelation in Genesis, and secondly that, if there be, it is one which has no serious or relevant meaning. He comes to the remarkable expression in v. 26, "Let *us* make man in our own image." There has, it appears, been much difference of opinion even among the Jews on the meaning of this verse. The Almighty addresses, as some think, His own powers; as others think, the angels; others, the earth; other writers, especially, as it appears, Germans, have understood this to be a plural of dignity after the manner of kings. Others, of the rationalizing school, conceive the word Elohim to be a relic of polytheism. The ancient Christian interpreters,* from the Apostle Barnabas onward, find in these words an indication of a plurality in the Divine Unity. Dr. Réville (p. 43) holds that this is "simply the royal plural used in Hebrew as in many other languages," or else, and more probably, that it is an appeal to the Bené Elohim or angels. But is not this latter meaning a direct assault upon the supreme truth of the Unity of God? If he chooses the former, from whence does he derive his knowledge that this "royal plural" was used in Hebrew? Will the royal plural account for (Gen. iii, 22) "when the man is become as one of us"? and would

* "Samson Agonistes."

* On this expression, I refer again to the commentary of Bishop Harold Browne. Bishop Mant supplies an interesting list of testimonies.

George the Second, if saying of Charles Edward "the man is become as one of us," have intended to convey a singular or a plural meaning? Can we disprove the assertion of Bishop Harold Browne, that this plurality of dignity is unknown to the language of Scripture? And further, if we make the violent assumption that the Christian Church with its one voice is wrong and Dr. Réville right, and that the words were not meant to convey the idea of plurality, yet, if they have been such as to lead all Christendom to see in them this idea through 1800 years, how can he be sure that they did not convey a like signification to the earliest hearers or readers of the Book of Genesis?

The rest of Dr. Réville's criticism is directed rather to the significance or propriety, than to the truth, of the record. It is not necessary to follow his remarks in detail, but it will help the reader to judge how far even a perfectly upright member of the scientific and comparative school can indulge an unconscious bias, if notice be taken in a single instance of his method of comparing. He compares together the two parts of the prediction that the seed of the woman shall bruise the head of the serpent, and that the serpent shall bruise the heel of the seed of the woman (iii, 15); and he conceives the head and the heel to be so much upon a par in their relation to the faculties and the vitality of a man that he can find here nothing to indicate which shall get the better, or, in his own words, "on which side shall be the final victory" (p. 45). St. Paul seems to have taken a different view when he wrote, "the God of peace shall bruise Satan under your feet shortly" (Rom. xvi., 20).

Moreover, "our author" (in Dr. Réville's phrase) is censured because he "takes special care to point out" (p. 44) "that the first pair are as yet strangers to the most elementary notions of morality," inasmuch as they are unclothed, yet without shame; nay, even, as he feelingly says, "without the least shame." In what the morality of the first pair consisted, this is hardly the place to discuss. But let us suppose for a moment that their morality was simply the morality of a little child, the undeveloped morality of obedience, without distinctly formed conceptions of an ethical or abstract standard. Is it not plain that their feelings would have been exactly what the Book describes (Gen. ii, 25), and yet that in their loving obedience to their Father and Creator they would certainly have had a germ, let me say an opening bud, of morality? But this proposition, taken alone, by no means does justice to the case. Dr. Réville would probably put aside with indifference or contempt all that depends upon the dogma of the Fall. And yet there can be no more rational idea, no idea more palpably sustained, whether by philosophy or by experience. Namely, this idea: that the commission of sin, that is, the act of deliberately breaking a known law of duty, injures the nature and composition of the being who commits it. It injures that nature in deranging it, in altering the proportion of its parts and powers, in introducing an inward disorder and rebellion of the lower against the higher, too mournfully corresponding with that disorder and rebellion produced without, as toward God, of which the first sin was the fountain head. Such is, I believe, the language of Christian theology, and in particular of St. Augustine, one of its prime masters. On this matter I apprehend that Dr. Réville, when judging the author of Genesis, judges him without regard to his fundamental ideas and aims, one of which was to convey that before sinning man was a being morally and physically balanced, and nobly pure in every faculty; and that, by and from his sinning, the sense of shame found a proper and necessary place in a nature which before was only open to the sense of duty and of reverence.

One further observation only. Dr. Réville seems to "score one" when he finds (Gen. iv, 26) that Seth had a son, and that "then began men to call on the name of the Lord"; "but not," he adds, "as the result of a recorded revelation." Here at last he has found, or seemed to find, the beginning of religion, and that beginning subjective, not revealed. So hastily, from the first aspect of the text, does he gather a verbal advantage, which, upon the slightest inquiry, would have disappeared like dew in the morning sun. He assumes the rendering of a text which has been the subject of every kind of question and dispute, the only thing apparently agreed on being that his interpretation is wholly excluded. Upon a disputed original, and a disputed interpretation of the disputed original, he founds a signification in that contradiction to the whole of the former narrative, to Elohist and Jehovist alike; which narrative, if it represents anything, represents a continuity of active reciprocal relation between God and man both before and after the transgression. Not to mention differences of translation, which essentially change the meaning of the words, the text itself is given by the double authority of the Samaritan Pentateuch * and of the Septuagint in the singular number, which of itself wholly destroys the construction of Dr. Réville. I do not enter upon the difficult question of conflicting authorities, but I urge that it is unsafe to build an important conclusion upon a seriously controverted reading.†

There is nothing, then, in the criticisms of Dr. Réville but what rather tends to confirm than to impair the old-fashioned belief that there is a revelation in the Book of Genesis. With his argument outside this proposition I have not dealt. I make no assumption as to what is termed a verbal inspiration, and, of course, in admitting the variety, I give up the absolute integrity of the text. Upon the presumable age of the book and its compilation I do not enter—not even to contest the opinion which brings it down below the age of Solomon—beyond observing that in every page it appears from internal evidence to belong to a remote antiquity. There is here no question of the chronology or of the date of man, or of knowledge or ignorance in the primitive man; or whether the element of parable enters into any portion of the narrative; or whether every statement of fact contained in the text of the Book can now be made good. It is enough for my present purpose to point to the cosmogony, and the fourfold succession of the living organisms, as entirely harmonizing, according to present knowledge, with belief in a revelation, and as presenting to the rejector of that belief a problem, which demands solution at his hands, and which he has not yet been able to solve. Whether this revelation was conveyed to the ancestors of the whole human race who have at the time or since existed, I do not know, and the Scriptures do not appear to make the affirmation, even if they do not convey certain indications which favor a contrary opinion. Again, whether it contains the whole of the knowledge specially vouchsafed to the parents of the Noachian races, may be very doubtful; though of course great caution must be exercised in regard to the particulars of any primeval tradition not derived from the text of the earliest among the sacred books. I have thus far confined myself to rebutting objections. But I will now add some positive considerations which appear to me to sustain the ancient and, as I am persuaded, impregnable belief of Christians and of Jews concerning the inspiration of the Book. I offer them as one wholly destitute of that kind of knowledge which carries authority, and who speaks derivatively as best he can, after listening to teachers of repute and such as practice rational methods.

I understand the stages of the majestic process described in the Book of Genesis to be in general outline as follows:

1. The point of departure is the formless mass, created by God, out of which the earth was shaped and constituted a thing of individual existence (verses 1, 2).

2. The detachment and collection of light, leaving in darkness as it proceeded the still chaotic mass from which it was detached (verses 3–5). The narrative assigning a space of time to each process appears to show that each was gradual, not instantaneous.

3. The detachment of light from darkness is followed by the detachment of wet from dry, and of solid from liquid, in the firmament, and on the face of the earth. Each of these operations occupies a "day"; and the conditions of vegetable life, as known to us by experience, being now provided, the order of the vegetable kingdom had begun (verses 6–13).

4. Next comes the presentation to us of the heavenly bodies, sun, moon, and stars,

* See Bishop of Winchester's "Commentary."

† This perplexed question is discussed, in a sense adverse to the Septuagint, by the critic of the recent revision, in the "Quarterly Review" for October, No. 322. The revisers of the Old Testament state (Preface, p. vi) that in a few cases of extreme difficulty they have set aside the Masoretic text in favor of a reading from one of the ancient versions.

in their final forms, when the completion of the process of light-collection and concentration in the sun, and the due clearing of the intervening spaces, had enabled the central orb to illuminate us both with direct and with reflected light (verses 14–19).

5. So far, we have been busy only with the adjustment of material agencies. We now arrive at the dawn of animated being; and a great transition seems to be marked as a kind of recommencement of the work, for the name of creation is again introduced. God created—

(*a*) The water-population;

(*b*) The air-population.

And they receive His benediction (verses 20–23).

6. Pursuing this regular progression from the lower to the higher, from the simple to the complex, the text now gives us the work of the sixth "day," which supplies the land-population, air and water having already been supplied. But in it there is a subdivision, and the transition from (*c*) animal to (*d*) man, like the transition from inanimate to animate, is again marked as a great occasion, a kind of recommencement. For this purpose the word "create" is a third time employed. "God created man in His own image," and once more He gave benediction to this the final work of His hands, and endowed our race with its high dominion over what lived and what did not live (verses 24–31).

I do not dwell on the cessation of the Almighty from the creating and (ii, 1) "finishing" work, which is the "rest" and marks the seventh "day," because it introduces another order of considerations. But, glancing back at the narrative which now forms the first chapter, I offer perhaps a prejudiced, and in any case no more than a passing, remark. If we view it as popular narrative, it is singularly vivid, forcible, and effective; if we take it as a poem, it is indeed sublime. No wonder if it became classical and reappeared in the glorious devotions of the Hebrew people,* pursuing, in a great degree, the same order of topics as in the Book of Genesis.

But the question is not here of a lofty poem, or a skillfully constructed narrative: it is whether natural science, in the patient exercise of its high calling to examine facts, finds that the works of God cry out against what we have fondly believed to be His Word, and tell another tale; or whether, in this nineteenth century of Christian progress, it substantially echoes back the majestic sound which, before it existed as a pursuit, went forth into all lands.

First, looking largely at the latter portion of the narrative, which describes the creation of living organisms, and waiving details, on some of which (as in verse 24) the Septuagint seems to vary from the Hebrew, there is a grand fourfold division, set forth in an orderly succession of times as follows: on the fifth day—

1. The water-population;
2. The air-population;

and, on the sixth day,

3. The land-population of animals;
4. The land-population consummated in man.

Now this same fourfold order is understood to have been so affirmed in our time by natural science, that it may be taken as a demonstrated conclusion and established fact. Then, I ask, how came Moses, or, not to cavil on the word, how came the author of the first chapter of Genesis, to know that order, to possess knowledge which natural science has only within the present century for the first time dug out of the bowels of the earth? It is surely impossible to avoid the conclusion, first, that either this writer was gifted with faculties passing all human experience, or else his knowledge was divine. The first branch of the alternative is truly nominal and unreal. We know the sphere within which human inquiry toils. We know the heights to which the intuitions of genius may soar. We know that in certain cases genius anticipates science; as Homer, for example, in his account of the conflict of the four winds in sea-storms. But even in these anticipations, marvelous, and, so to speak, imperial as they are, genius can not escape from one inexorable law. It must have materials of sense or experience to work with, and a ποῦ στῶ from whence to take its flight; and genius can no more tell, apart from some at least of the results at-

* Ps. civ, 2–20, cxxxvi, 5–9, and the Song of the Three Children in verses 57–60.

tained by inquiry, what are the contents of the crust of the earth, than it could square the circle, or annihilate a fact.*

So stands the plea for a revelation of truth from God, a plea only to be met by questioning its possibility; that is, as Dr. Salmon † has observed with great force in a recent work, by suggesting that a Being, able to make man, is unable to communicate with the creature He has made. If, on the other hand, the objector confine himself to a merely negative position, and cast the burden of proof on those who believe in revelation, it is obvious to reply by a reference to the actual constitution of things. Had that constitution been normal or morally undisturbed, it might have been held that revelation as an *adminiculum*, an addition to our natural faculties, would itself have been a disturbance. But the disturbance has in truth been created in the other scale of the balance by departure from the Supreme Will, by the introduction of sin: and revelation, as a special remedy for a special evil, is a contribution toward symmetry, and toward restoration of the original equilibrium.

Thus far only the fourfold succession of living orders has been noticed. But among the persons of very high authority in natural science quoted by Dr. Reusch,‡ who held the general accordance of the Mosaic cosmogony with the results of modern inquiry, are Cuvier and Sir John Herschel. The words of Cuvier show he conceived that "every day" fresh confirmation from the purely human source accrued to the credit of Scripture. And since his day, for he can not now be called a recent authority, this opinion appears to have received some remarkable illustrations.

Half a century ago, Dr. Whewell § discussed, under the name of the nebular hypothesis, that theory of rotation which had been indicated by Herschel, and more largely taught by Laplace, as the probable method through which the solar system has taken its form. Carefully abstaining, at that early date, from a formal judgment on the hypothesis, he appears to discuss it with favor; and he shows that this hypothesis, which assumes "a beginning of the present state of things,"* is in no way adverse to the Mosaic cosmogony. The theory has received marked support from opposite quarters. In the "Vestiges of Creation" it is frankly adopted; the very curious experiment of Professor Plateau is detailed at length on its behalf; † and the author considers, with Laplace, that the zodiacal light, on which Humboldt in his "Kosmos" has dwelt at large, may be a remnant of the luminous atmosphere originally diffused around the sun. Dr. McCaul, in his very able argument on the Mosaic record, quotes ‡ Humboldt, Pfaff, and Mädler—a famous German astronomer—as adhering to it. It appears on the whole to be in possession of the field; and McCaul observes § that, "had it been devised for the express purpose of removing the supposed difficulties of the Mosaic record, it could hardly have been more to the purpose." Even if we conceive, with Dr. Réville, that the "creation," the first gift of separate existences to the planets, is declared to have been subsequent to that of the earth, there seems to be no known law which excludes such a supposition, especially with respect to the larger and more distant of their number. These, it is to be noticed, are of great rarity as compared with the earth. Why should it be declared impossible that they should have taken a longer time in condensation, like in this point to the comets, which still continue in a state of excessive rarity? Want of space forbids me to enter into further explanation; but it requires much more serious efforts and objections than those of Dr. Réville to confute the statement that the extension of knowledge and of inquiry has confirmed the Mosaic record.

* In conversation with Miss Burney ("Diary," i. 576), Johnson, using language which sounds more disparaging than it really is, declares that "Genius is nothing more than knowing the use of tools; but then there must be tools for it to use."

† "Introduction to the New Testament," p. ix. Murray, 1885.

‡ "Bibel und Natur," pp. 2, 63. The words of Cuvier are: "Moyses hat uns eine Kosmogonie hinterlassen, deren Genauigkeit mit jedem Tage in einer bewunderungswürdigern Weise bestätigt ist." The declaration of Sir John Herschel was in 1861.

§ Whewell's "Astronomy and General Physics," 1834, p. 181 *seqq.*

* Whewell, *op. cit.*, p. 206.

† "Vestiges," etc., pp. 11-15.

‡ "Aids to Faith," p. 210. § Ibid.

One word, however, upon the "days" of Genesis. We do not hear the authority of Scripture impeached on the ground that it assigns to the Almighty eyes and ears, hands, arms, and feet; nay, even the emotions of the human being. This being so, I am unable to understand why any disparagement to the credit of the sacred books should ensue because, to describe the order and successive stages of the Divine working, these have been distributed into "days." What was the thing required in order to make this great procession of acts intelligible and impressive? Surely it was to distribute the parts each into some integral division of time, having the character of something complete in itself, of a revolution, or outset and return. There are but three such divisions familiarly known to man. Of these the day was the most familiar to human perceptions; and probably on this account its figurative use is admitted to be found in prophetic texts, as, indeed, it largely pervades ancient and modern speech. Given the object in view, which indeed can hardly be questioned, does it not appear that the "day," more definitely separated than either month or year from what precedes and what follows, was appropriately chosen for the purpose of conveying the idea of development by gradation in the process which the book sets forth?

I now come to the last portion of my task, which is to follow Dr. Réville into his exposition of the Olympian mythology. Not, indeed, the Homeric or Greek religion alone, for he has considered the case of all religions, and disposes of them with equal facility. Of any other system than the Olympian, it would be presumption in me to speak, as I have, beyond this limit, none but the most vague and superficial knowledge. But on the Olympian system in its earliest and least adulterated, namely, its Homeric, development, whether with success or not, I have freely employed a large share of such leisure as more than thirty years of my Parliamentary life, passed in freedom from the calls of office, have supplied. I hope that there is not in Dr. Réville's treatment of other systems that slightness of texture and that facility and rapidity of conclusion which seem to me to mark his performances in the Olympian field.

In the main he follows what is called the solar theory. In his widest view he embraces no more than "the religion of nature" (pp. 94, 100), and he holds that all religion has sprung from the worship of objects visible and sensible.

His first essay is upon Heracles, whom I have found to be one of the most difficult and, so to speak, irreducible characters in the Olympian mythology. In the Tyrian system Heracles, as Melkart, says Dr. Réville in p. 95, is "a brazen god, the devourer of children, the terror of men"; but, without any loss of identity, he becomes in the Greek system "the great lawgiver, the tamer of monsters, the peacemaker, the liberator." I am deeply impressed with the danger that lurks in these summary and easy solutions; and I will offer a few words first on the Greek Heracles generally, next on the Homeric presentation of the character.

Dr. L. Schmidt has contributed to Smith's great Dictionary a large and careful article on Heracles—an article which may almost be called a treatise. Unlike Dr. Réville, to whom the matter is so clear, he finds himself out of his depth in attempting to deal with this highly incongruous character, which meets us at so many points, as a whole. But he perceives in the Heracles of Greece a mixture of fabulous and historic elements; and the mythical basis is not, according to him, a transplanted Melkart, but is essentially Greek.* He refers to Buttmann's "Mythologus" and Müller's "Dorians" as the best treatises on the subject, "both of which regard the hero as a purely Greek character." Thus Dr. Réville appears to be in conflict with the leading authorities, whom he does not confute, but simply ignores.

Homer himself may have felt the difficulty, which Dr. Réville does not feel, for he presents to us, in one and the same passage, a divided Heracles. Whatever of him is not *eidolon*,† dwells among the Olympian gods. This *eidolon*, however, is no mere shade, but something that sees and speaks, that mourns and threatens; no "lawgiver," or "peacemaker," or "liberator," but one from whom the other shades fly in terror, set in the place and company of sinners suf-

* Smith's "Dictionary," ii, 400.

† "Od.," xi, 601–4.

fering for their sins, and presumably himself in the same predicament, as the sense of grief is assigned to him: it is in wailing that he addresses Odysseus.* Accordingly, while on earth, he is *thrasumemnon*,† *huperthumos*,‡ a doer of *megala erga*,§ which with Homer commonly are crimes. He is profane, for he wounded Herè, the specially Achaian goddess; ‖ and he is treacherous, for he killed Iphitos, his host, in order to carry off his horses.¶ A mixed character, no doubt, or he would not have had Hebò for a partner; but those which I have stated are some of the difficulties which Dr. Réville quietly rides over to describe him as lawgiver, peacemaker, and liberator. But I proceed.

Nearly everything, with Dr. Réville, and, indeed, with his school, has to be pressed into the service of the solar theory; and, if the evidence will not bear it, so much the worse for the evidence. Thus Ixion, tortured in the later Greek system on a wheel, which is sometimes represented as a burning wheel, is made (p. 105) to be the sun; the luminary whose splendor and beneficence had rendered him, according to the theory, the center of all Aryan worship. A sorry use to put him to; but let that pass. Now the occasion that supplies an Ixion and a burning wheel available for solarism—a system which prides itself above all things on its exhibiting the primitive state of things—is that Ixion had loved unlawfully the wife of Zeus. And first as to the wheel: We hear of it in Pindar;** but as a winged not a burning wheel. This "solar" feature appears, I believe, nowhere but in the latest and most defaced and adulterated mythology. Next as to the punishment. It is of a more respectable antiquity. But some heed should surely be taken of the fact that the oldest authority upon Ixion is Homer; and that Homer affords no plea for a burning or any other wheel, for, according to him,†† instead of Ixion's loving the wife of Zeus, it was Zeus who loved the wife of Ixion.

Errors, conveyed without testimony in a sentence, commonly require many sentences to confute them. I will not dwell on minor cases, or those purely fanciful; for mere fancies, which may be admired or the reverse, are impalpable to the clutch of argument, and thus are hardly subjects for confutation. *Paulò majora canamus.* I continue to tread the field of Greek mythology, because it is the favorite sporting-ground of the exclusivists of the solar theory.

We are told (p. 80) that because waves with rounded backs may have the appearance (but query) of horses or sheep throwing themselves tumultuously upon one another, therefore "in maritime regions, the god of the liquid element, Poseidon or Neptune, is the breeder, protector, and trainer of horses." Then why is he not also the breeder, protector, and trainer of sheep? They have quite as good a maritime title; according to the fine line of Ariosto:

> "Muggendo van per mare I gran montoni."

I am altogether skeptical about these rounded backs of horses, which, more, it seems, than other backs, become conspicuous like a wave. The resemblance, I believe, has commonly been drawn between the horse, as regards his mane, and the foam-tipped waves, which are still sometimes called white horses. But we have here, at best, a case of a great superstructure built upon a slight foundation; when it is attempted, on the groundwork of a mere simile, having reference to a state of sea which in the Mediterranean is not the rule but the rare exception, to frame an explanation of the close, pervading, and almost profound relation of the Homeric Poseidon to the horse. Long and careful investigation has shown me that this is an ethnical relation, and a key to important parts of the ethnography of Homer. But the proof of this proposition would require an essay of itself. I will, therefore, only refer to the reason which leads Dr. Réville to construct this (let me say) castle in the air. It is because he thinks he is accounting hereby for a fact, which would indeed, if established, be a startling one, that the god of the liquid element should also be the god of the horse. We are dealing now especially with the Homeric Poseidon, for it is in Homer that the relation to the horse is developed; and the way to a true explanation is opened when we observe that the

* "Od.," xi, 605–16.
† "Od.," xi, 267.
‡ "Il.," xiv, 250.
§ "Od.," xxi, 26.
‖ "Il.," v, 392.
¶ "Od.," xxi, 26–30.
** "Pyth.," ii, 39.
†† "Il.," xiv, 317.

Homeric Poseidon is *not* the god of the liquid element at all.

The truth is that the Olympian and ruling gods of Homer are not elemental. Some few of them bear the marks of having been elemental in other systems; but, on admission into the Achaian heaven, they are divested of their elemental features. In the case of Poseidon, there is no sign that he ever had these elemental features. The signs are unequivocal that he had been worshiped as supreme, as the Zeus-Poseidon, by certain races and in certain, viz., in far southern, countries. Certainly he has a special relation to the sea. Once, and once only, do we hear of his having a habitation under water.* It is in "Il.," xiii, where he fetches his horses from it, to repair to the Trojan plain. He seems to have been an habitual absentee; the prototype, he might be called, of that ill-starred, ill-favored class. We hear of him in Samothrace, on the Solyman Mountains, as visiting the Ethiopians † who worshiped him, and the reek of whose offerings he preferred at such times to the society of the Olympian gods debating on Hellenic affairs; though, when we are in the zone of the Outer Geography, we find him actually presiding in an Olympian assembly marked with foreign associations.‡ Now compare with this great mundane figure the true elemental gods of Homer: first Okeanos, a venerable figure, who dwells appropriately by the farthest § bound of earth, the bank of the Ocean-river, and who is not summoned ‖ even to the great Olympian assembly of the Twentieth Book; and secondly, the graybeard of the sea, whom only from the patronymic of his Nereid daughters we know to have been called Nereus, and who, when reference is made to him and to his train, is on each occasion ¶ to be found in one and the same place, the deep recesses of the Mediterranean waters. If Dr. Réville still doubts who was for Homer the elemental god of water, let him note the fact that while *neros* is old Greek for *wet*, *nero* is, down to this very day, the people's word for *water*. But, conclusive as are these considerations, their force will be most fully appreciated only by those who have closely observed that Homer's entire theurgic system is resolutely exclusive of Nature-worship, except in its lowest and most colorless orders, and that where he has to deal with a Nature-power of serious pretensions, such as the Water-god would be, he is apt to pursue a method of quiet suppression, by local banishment or otherwise, that space may be left him to play out upon his board the gorgeous and imposing figures of his theanthropic system.

* "Il.," xiii, 17–31.
† "Od.," i, 25, 26.
‡ "Od.," viii, 321–66.
§ "Il.," xiv, 201.
‖ "Il.," xx, 7.
¶ "Il.," i, 358; xviii, 36.

As a surgeon performs the most terrible operation in a few seconds, and with unbroken calm, so does the school of Dr. Réville, at least within the Homeric precinct, marshal, label, and transmute the personages that are found there. In touching on the "log," by which Dr. Réville says Hera was represented for ages, she is quietly described as the "Queen of the shining Heaven" (p. 79). For this assumption, so naïvely made, I am aware of no authority whatever among the Greeks—a somewhat formidable difficulty for others than solarists, as we are dealing with an eminently Greek conception. Euripides, a rather late authority, says,* she dwells among the stars, as all deities might be said, *ex officio*, to do; but gives no indication either of identity or of queenship. Etymology, stoutly disputed, may afford a refuge. Schmidt † refers the name to the Latin *hera;* Curtius ‡ and Preller § to the Sanskrit *svar*, meaning the heaven; and Welcker,‖ with others, to what appears the more obvious form of ἔρα, the earth. Dr. Réville, I presume, makes choice of the Sanskrit *svar*. Such etymologies, however, are, though greatly in favor with the solarists, most uncertain guides to Greek interpretation. The effect of trusting to them is that, if a deity has in some foreign or anterior system had a certain place or office, and if this place or office has been altered to suit the exigencies of a composite mythology, the Greek idea is totally misconceived. If we take the pre-name of the Homeric Apollo, we may with some plausi-

* Eurip., "Helena," 109.
† Smith's "Dict.," art. "Hera."
‡ "Griech. Etymol.," p. 119.
§ Preller, "Griech. Mythol.," i, 121.
‖ "Griech. Götterlehre," i, 362–3.

bility say the *Phoibos* of the poet is the Sun; but we are landed at once in the absurd consequence that we have got a Sun already,* and that the two are joint actors in a scene of the eighth *Odyssey*.† Strange, indeed, will be the effect of such a system if applied to our own case at some date in the far-off future; for it will be shown, *inter alia*, that there were no priests, but only presbyters, in any portion of Western Christendom; that our dukes were simply generals leading us in war; that we broke our fast at eight in the evening (for *dîner* is but a compression of *déjeuner*); and even, possibly, that one of the noblest and most famous of English houses pursued habitually the humble occupation of a pig-driver.

The character of Hera, or Heré, has received from Homer a full and elaborate development. There is in it absolutely no trace whatever of "the queen of the shining heaven." In the action of the "Odyssey" she has no share at all—a fact absolutely unaccountable if her function was one for which the voyages of that poem give much more scope than is supplied by the "Iliad." The fact is, that there is no queen of heaven in the Achaian system; nor could there be without altering its whole genius. It is a curious incidental fact that, although Homer recognizes to some extent humanity in the stars (I refer to Orion and Leucotheë, both of them foreign personages of the Outer Geography), he never even approximates to a personification of the real queen of heaven, namely, the moon. There happens to be one marked incident of the action of Hera, which stands in rather ludicrous contrast with this lucent queenship. On one of the occasions when, in virtue of her birth and station, she exercises some supreme prerogative, she directs the sun (surely not so to her lord and master) to set, and he reluctantly obeys.‡ Her character has not any pronounced moral elements; it exhibits pride and passion; it is pervaded intensely with policy and nationalism; she is beyond all others the Achaian goddess, and it is sarcastically imputed to her by Zeus that she would eat the Trojans if she could, and eat them without requiring in the first instance any culinary process.* I humbly protest against mauling and disfiguring this work; against what great Walter Scott would, I think, have called "mashackering and misguggling" it, after the manner of Nicol Muschat, when he put an end to his wife Ailie † at the spot afterward marked by his name. Why blur the picture so charged alike with imaginative power and historic meaning, by the violent obtrusion of ideas, which, whatever force they may have had among other peoples or in other systems, it was one of the main purposes of Homer, in his marvelous theurgic work, to expel from all high place in the order of ideas, and from every corner, every loft and every cellar, so to speak, of his Olympian palaces?

If the Hera of Homer is to own a relationship outside the Achaian system, like that of Apollo to the sun, it is undoubtedly with Gaia, the earth, that it can be most easily established. The all-producing function of Gaia in the Theogony of Hesiod ‡ and her marriage with Ouranos, the heaven, who has a partial relation to Zeus, points to Hera as the majestic successor who in the Olympian scheme, as the great mother and guardian of maternity, bore an analogical resemblance to the female head of one or more of the Pelasgian or archaic theogonies that it had deposed.

I have now done with the treatment of details, and I must not quit them without saying that there are some of the chapters, and many of the sentences, of Dr. Réville which appear to me to deserve our thanks. And, much as I differ from him concerning an essential part of the historic basis of religion, I trust that nothing which I have said can appear to impute to him any hostility or indifference to the substance of religion itself.

I make, indeed, no question that the solar theory has a most important place in solving the problems presented by many or some of the Aryan religions; but whether it explains their first inception is a totally different matter. When it is ruthlessly applied, in the teeth of evidence, to them all, in the last resort it stifles facts, and reduces observation and reasoning to a mock-

* See "Infra." † "Od.," viii, 302, 334.
‡ "Il.," xviii, 239, 240.

* "Il.," iv, 35. † "Heart of Midlothian."
‡ "Theog.," 116–136.

ery. Sir George Cox, its able advocate, fastens upon the admission that some one particular method is not available for all the phenomena, and asks, Why not adopt for the Greek system, for the Aryan systems at large, perhaps for a still wider range, "a clear and simple explanation," namely, the solar theory?* The plain answer to the question is, that this must not be done, because, if it is done, we do not follow the facts, nor are led by them; but, to use the remarkable phrase of Æschylus,† we ride them down, we trample them under foot. Mankind has long been too familiar with a race of practitioners, whom courtesy forbids to name, and whose single medicine is alike available to deal with every one of the thousand figures of disease. There are surely many sources to which the old religions are referable. We have solar worship, earth worship, astronomic worship, the worship of animals, the worship of evil powers, the worship of abstractions, the worship of the dead, the foul and polluting worship of bodily organs, so widespread in the world, and especially in the East; last, but not least, I will name terminal worship, the remarkable and most important scheme which grew up, perhaps first on the Nile, in connection with the stones used for marking boundaries, which finds its principal representative in the god Hermes, and which is very largely traced and exhibited in the first volume of the work of M. Dulaure ‡ on ancient religions.

But none of these circumstances discredit or impair the proof that in the Book, of which Genesis is the opening section, there is conveyed special knowledge to meet the special need everywhere so palpable in the state and history of our race. Far indeed am I from asserting that this precious gift, or that any process known to me, disposes of all the problems, either insoluble or unsolved, by which we are surrounded; of

"the burden and the mystery
Of all this unintelligible world."

But I own my surprise not only at the fact, but at the manner in which in this day, writers, whose name is Legion, unimpeached in character and abounding in talent, not only put away from them, cast into shadow or into the very gulf of negation itself, the conception of a Deity, an acting and a ruling Deity. Of this belief, which has satisfied the doubts, and wiped away the tears, and found guidance for the footsteps of so many a weary wanderer on earth, which among the best and greatest of our race has been so cherished by those who had it, and so longed and sought for by those who had it not, we might suppose that if at length we had discovered that it was in the light of truth untenable, that the accumulated testimony of man was worthless, and that his wisdom was but folly, yet at least the decencies of mourning would be vouchsafed to this irreparable loss. Instead of this, it is with a joy and exultation that might almost recall the frantic orgies of the Commune, that this, at least at first sight, terrific and overwhelming calamity is accepted, and recorded as a gain. One recent, and, in many ways, respected writer—a woman long wont to unship creed as sailors discharge excess of cargo in a storm, and passing at length into formal atheism—rejoices to find herself on the open, free, and "breezy common of humanity." Another, also woman, and dealing only with the workings and manifestations of God, finds * in the theory of a physical evolution as recently developed by Mr. Darwin, and received with extensive favor, both an emancipation from error and a novelty in kind. She rejoices to think that now at last Darwin "shows life as an harmonious whole, and makes the future stride possible by the past advance." Evolution, that is physical evolution, which alone is in view, may be true (like the solar theory), may be delightful and wonderful, in its right place; but are we really to understand that varieties of animals brought about through domestication, the wasting of organs (for instance, the tails of men) by disuse, that natural selection and the survival of the fittest, all in the physical order, exhibit to us the great *arcanum* of creation, the sum and center of life, so that mind and spirit are dethroned from their old supremacy, and no longer sovereign by right, but

* "Mythology of Aryan Nations," I, 18.

† καθιππάζεσθαι: a remarkable word, as applied to moral subjects, found in the "Eumenides" only.

‡ "Histoire abrégée de différens Cultes." Seconde édition. Paris, 1825.

* I do not quote names, but I refer to a very recent article in one of our monthly periodicals.

may find somewhere by charity a place assigned them, as appendages, perhaps only as excrescences, of the material creation? I contend that Evolution in its highest form has not been a thing heretofore unknown to history, to philosophy, or to theology. I contend that it was before the mind of Saint Paul when he taught that in the fullness of time God sent forth His Son, and of Eusebius, when he wrote the "Preparation for the Gospel," and of Augustine when he composed the "City of God"; and, beautiful and splendid as are the lessons taught by natural objects, they are, for Christendom at least, infinitely beneath the sublime unfolding of the great drama of human action, in which, through long ages, Greece was making ready a language and an intellectual type, and Rome a framework of order and an idea of law, such that in them were to be shaped and fashioned the destinies of a regenerated world. For those who believe that the old foundations are unshaken still, and that the fabric built upon them will look down for ages on the floating wreck of many a modern and boastful theory, it is difficult to see anything but infatuation in the destructive temperament which leads to the notion that to substitute a blind mechanism for the hand of God in the affairs of life is to enlarge the scope of remedial agency; that to dismiss the highest of all inspirations is to elevate the strain of human thought and life; and that each of us is to rejoice that our several units are to be disintegrated at death into "countless millions of organisms"; for such, it seems, is the latest "revelation" delivered from the fragile tripod of a modern Delphi. Assuredly on the minds of those who believe, or else on the minds of those who after this fashion disbelieve, there lies some deep judicial darkness, a darkness that may be felt. While disbelief in the eyes of faith is a sore calamity, this kind of disbelief, which renounces and repudiates with more than satisfaction what is brightest and best in the inheritance of man, is astounding, and might be deemed incredible. Nay, some will say, rather than accept the flimsy and hollow consolations which it makes bold to offer, might we not go back to solar adoration, or, with Goethe, to the hollows of Olympus?

"Wenn die Funke sprüht,
Wenn die Asche glüht,
Eilen wir den alten Göttern zu." *

TRANSLATION.

"When the sparks glitter,
When the ashes glow,
We speed us to the old gods."

Nineteenth Century.

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* "Braut von Corinth."

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