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SEWER-GAS.

By FRANK HASTINGS HAMILTON, M. D.

ON the 2d of February last Mr. Charles F. Wingate, sanitary engineer, read before the New York Academy of Medicine a paper entitled "Practical Points in Plumbing," etc. Before introducing Mr. Wingate, the president, Dr. Fordyce Barker, read a brief paper, relating his personal experience as to the dangerous nature of sewer-gas, and asking for the earnest attention of the Academy to this subject. The reading of Mr. Wingate's paper was followed by a series of experiments, made by Professor R. Ogden Doremus, intended to illustrate the difficulty of preventing the escape of these gases by either water-traps, lead, iron, or earthen pipes. A large number of physicians and surgeons were present, among whom were many who, on account of their practical experience in matters of hygiene, had been invited by the president to take part in the discussion.

Reflecting subsequently upon the great importance of the subject which had been under debate, I prepared and read before the Academy, on the evening of March 16th, a paper entitled "The Struggle for Life against Civilization and Æstheticism." The purpose of this paper was to furnish a *résumé* of the papers, experiments, and discussions of the February meeting, and to suggest the conclusions which seemed to be authorized, but which the Academy had not attempted to formulate or declare.

Before closing my communication, attention was drawn by me to other matters than plumbing, such, for example, as house sanitation in general and physical hygiene ; but which subjects, at my request, were not made matters of discussion on that occasion. My conclusions were given as follows :

If these sanitary engineers, plumbers, chemists, and hygienists, who were requested to take part in the discussion because of their acknowledged scientific attainments, experience, and practical skill, have nothing more to suggest, how is the evil to be successfully met?

With all respect to the distinguished gentlemen, I must say that they have suggested nothing of any importance which is new; nothing that was not known before; nothing, indeed, which has not been tried, and which has not, for one reason or another, proved itself to be either impracticable or insufficient, and in many cases totally inefficient.

My reply to this question is that, in reference to these matters, science has not kept pace with civilization, and that, without concessions on the part of civilization, there is at present no adequate remedy. . . .

I repeat, then, that in order to render pure and innocuous the atmosphere of our houses, whether the sources of its impurity are to be found in our present systems of lighting, heating, or drainage, it will be necessary, first of all, that civilization should make some concessions.

The term "civilization" is here used in its broad and legitimate sense, as including not only mental culture, with progress in science and art, but also the comforts, luxuries, and æsthetics of life, which are its natural and inevitable concomitants. If certain of the latter elements of civilization can not be dispensed with, it will be found impossible, I fear, to contend successfully with typhoid fever, diphtheria, and many other diseases which now contribute so largely to the increase of our mortality rates.

If we limit ourselves to the consideration of the unwholesome atmosphere of our houses—although this does not by any means constitute the only possible or probable source of sickness and physical decay incident to civilization—the concessions demanded, as a condition of the successful application of our present knowledge of the laws of hygiene, are:

1. That all plumbing having any direct or indirect communication with the sewers shall be excluded from those portions of our houses which we habitually occupy. In other words, that it shall be placed in a separate building, or annex.

2. That we return to the open fire-place, or the grate, as a means of warming our private houses.

3. A diminished consumption of oxygen by gas-burners. It is still an open question whether we shall be able to light our dwellings with electricity; but so long as we are obliged to depend upon gas we must content ourselves with light, and not insist upon illumination.

The concessions demanded have been named in the order of their importance. The necessity for each is urgent, but the first admits of no compromise.*

The purpose of the present paper is to determine whether, after the citation and careful study of other facts and observations than those laid before the Academy, my conclusions, so far as relates to the matters of sewer-gas and plumbing, can be regarded as defensible.

What is "sewer-gas"?

This term has been employed a long time by chemists, sanitarians, plumbers, and others, to indicate the ordinary emanations from sewers; but recently certain gentlemen have taken exceptions to the term,

* "New York Medical Gazette," March 25, 1882.

denying that there is any such thing as sewer-gas "having a peculiar and definite composition." This is undoubtedly true, and it is probable that no intelligent man or educated physician ever thought otherwise.

"What has been called 'sewer-gas' is composed of air, vapor, and gases in constantly varying proportions, together with living germs—vegetable and animal—and minute particles of putrescent matter. In short, it is composed of whatever is sufficiently volatile or buoyant to float in the atmosphere, and in consequence of which buoyancy it is permitted to escape through the various sewer-outlets. The term is, in this sense, well understood; and it is, moreover, just as correct as would be the terms sewer-vapor, or sewer-air, which some have chosen to substitute for it.

It is proper here to add that the offensiveness of odors is no test of their insalubrity, but that the most fatal germs are often conveyed in an atmosphere which is odorless. The absence of unpleasant odors, therefore, furnishes no proof that the air does not contain sewer emanations.

Have we succeeded hitherto in excluding sewer-gases from our houses?

Only those gentlemen who profess to have inquired carefully into this matter, and whose names will be accepted as authority, will be permitted to answer this question.

Colonel George B. Waring, Jr., sanitary engineer, writing for the "Herald," and also the "Mail and Express," under date of April 2, 1882, says: "Few, I imagine, would question the substantial soundness of Dr. Hamilton's position on the question of heating, lighting, and ventilation, and no one probably at all familiar with the subject will question what he says about the effect of the plumbing work of city houses on the life and health of their occupants. From tenement-house to palace they are very often, almost universally, disgracefully and dangerously bad. . . . It is quite true that such plumbing work as is to be found in nine out of every ten houses, even in Fifth Avenue, is unsafe, and ought not to be allowed to remain within the same four walls with a family of human beings."

Mr. Charles F. Wingate, sanitary engineer, in his paper read before the Kings County Medical Society, April, 1882, says: "Any one having opportunities for seeing the sanitary defects in the vast majority of city houses, whether occupied by millionaires or mechanics, and whether situated on Murray Hill or Avenue B, can feel little surprise at the statistics of increasing mortality in New York. The constant demand for the doctor's services in so many houses in their normally bad state, and the fact that his services are no longer demanded when they have been put in sanitary condition, tells its own lesson."

Mr. Wingate also intimates to the people of Brooklyn that their houses are in no better condition.

W. K. Burton, Resident Engineer to the London Sanitary Protective Association, writing for "The Sanitary Record" for March 15, 1882, when speaking of the iron drain-pipes of London houses, says: "Either practically every house in London should have its drain unreservedly condemned, or a certain small amount of leakage must be allowed to pass. I do not propose to enter into the question as to what extent an inspector is justified in passing slight defects; but would point out that such faults as are small in extent, are almost universal, and are generally passed by inspectors, do not come strictly under the head of sins of the plumber."

These statements, made by acknowledged experts, render unnecessary any further evidence in support of the belief that we are at present, and have been for a long time, wholly unprotected against sewer-gas. They confirm an almost universal public sentiment also. Whatever may be the explanation, whether this defective condition of our plumbing is due to the ignorance or wickedness of plumbers, architects, or sanitary engineers, or to other causes, the fact is undoubtedly as has been stated, and this is sufficient for our present purpose.

What has been the effect of its admission into our dwelling-houses upon human life and health?

Formerly, medical men and hygienists seemed never to entertain a doubt upon this question. Not until very recently has it been intimated, from any source, that sewers were not, from their very nature and contents, vast reservoirs of noxious gases and vapors. Receiving, as they do in this city, and in many other large cities, the excreta, and more or less of the offal, animal and vegetable, of almost the entire population, and these masses of filth being often detained in these receptacles to undergo putrefaction in a warm and humid atmosphere, it would seem impossible that their exhalations should not be dangerous to life.

Dr. Fordyce Barker, President of the New York Academy of Medicine, in announcing the pending discussion on the subject of sewer-gas and plumbing, spoke as follows:

One of the avowed objects of this Academy, as expressed in its constitution, is the promotion of the public health. Strictly speaking, all of our scientific work is in this direction, but this meeting is, in a larger sense, devoted specifically to this object. There is not a physician in this city, engaged in active practice, who is not frequently called upon to see disease of various degrees of severity, often resulting in death, which has been caused by a poison. If we can see our patients early enough, we can successfully meet such poisons as arsenic, as corrosive sublimate, as aconite, and all of this class, because we have antidotes which will prevent their effect. But where the poison is introduced into the system so insidiously that the subject is unconscious of its absorption until its effects are produced, then it is not a question of antidotes, but the problem is, How shall we counteract its consequences, and how shall we keep our patients alive until the life-destroying agents have ceased to put in jeopardy the vital powers?

The special poisons to which I now refer are the gases resulting from defective plumbing, to which all classes—the poor occupants of tenement-houses, those who are able to command the necessaries and many of the luxuries of life, and those who live in the most expensive houses, and whose riches can buy everything but health—are alike exposed. None but physicians can know how general this poison is, and how positively it explains much of the disease that they are called upon to treat, and of the many sad deaths which follow.

When I assert that it is a daily experience with me to see persons whose general health is suffering from this poison, as manifested by *malaise*, loss of appetite and strength, slight febrile symptoms, diarrhœa, physical and mental depression; and that I have seen infants, children, and adults suffering from diphtheria, scarlet fever of a mild type, complicated with this disease and destroying life; those in vigorous health, students in colleges, ambitious and active young men in the professions or in the commercial or financial world, stricken down by typhoid fever, some struggling through the disease and others dying; and that the cause has been demonstrated to be this poison—I only state facts which are common in the experience of all physicians in this city. In some cases this has been the result of ignorance of the very unsanitary conditions which environed them. For example, two young men were stricken down with typhoid fever, one of whom died. They were not acquaintances, but occupied offices in the same building, in the vicinity of Wall Street. On investigation, it was found that there was not a trap in the whole building. In a house in which, but a few months before, several hundred dollars had been expended to put the building in perfect condition, a young man died of typhoid fever, and others of the family became ill, when it was found that a defective waste-pipe was saturating the house with poisonous gas. But such facts as these are so common and so well known to the profession that I need not dwell upon them.

It is the custom of many in this city, whose means will permit them to do so, to take their families for health and pleasure to various summer resorts at the sea-side, the mountains, and other attractive country hotels; but every year, for some time past, some of these places have proved fatal to health, and often to life, by typhoid fever. . . . None but physicians are alive to the fact that many of those living in beautiful and expensive houses in this city are like the inhabitants who dwell at the base of Mount Vesuvius, in a soft, balmy, voluptuous atmosphere, surrounded by vineyards and gardens luxuriant with the olive and the fig and the orange trees, which mask and hide the danger and desolation of the lava and ashes of disease. . . . The physician should never be an alarmist; he never can hoist the signal of danger, except when he sees the forewarning signs of an impending storm. Unfortunately, he never can see the danger from this position until its effects are already beginning to develop as shown by disease.

At this same meeting Professor Doremus gave us the painful story of the sudden prostration of his two sons, one of whom died, and the other recovered only after a prolonged illness; in both of which cases sewer-gas was ascertained to be the cause of the sickness.

"I would rather," said Professor Doremus, "have exposed my sons to the deadliest poisons in my laboratory, for which we have antidotes, while for the deadly effects of sewer-gas we have no remedy."

But what is the need of multiplying testimony upon this point when it is so abundantly supplied by the experience of every medical man, and, indeed, of almost every intelligent citizen? The history of civilized nations for the last few years is replete with startling examples of valuable lives sacrificed in this manner. From sewer-gas the Prince of Wales nearly lost his life in one of the princely houses of England, and the Duchess of Connaught had to be removed from Bagehot to escape death from the same cause, after about two hundred thousand dollars had been expended to put the house in order on the occasion of her confinement. We have still fresh in our memories the terrible sewer-gas disaster at the National Hotel in Washington, the fatal outbreak at the Philadelphia Centennial Fair-Grounds, the Springfield boarding-school, and Princeton; not to mention many equally signal examples in our own city, in Brooklyn, and in many parts of the United States, in all of which not a doubt could exist as to the cause of sickness and death.

What special forms of sickness or of disease may be caused or conveyed by sewer-gas?

Asphyxia, sudden death, or death occurring in a few hours after exposure. Examples of this variety or degree of septic infection are rare, and have seldom occurred, except when persons have entered the sewers. Now and then, however, ever since sewers were first constructed, occasional reports of such cases have been made through medical journals or other channels.

A general *malaise*, or *dyscrasy*, of an undefined character, but indicated by a loss of appetite and of strength, by diarrhœa, nervous prostration, or by a general impairment of health, which conditions are known to predispose to the occurrence of other diseases, and especially to the diseases of infancy and childhood, including diphtheria and scarlatina. It is known, also, as stated by Dr. Barker in the quotation already made, that these conditions of the general system, caused by the long-continued inhalation of sewer-gas, complicate the contagious or zymotic diseases of infancy, from whatever source they have been derived, and render them more intense and fatal.

To be more explicit, sewer-gas fertilizes the human soil, and renders it more capable of receiving and developing the germs of specific diseases.

Infants and children are in general constitutionally better prepared for the reception and development of these germs, excepting, perhaps, the typhoid, than adults.

It has been asked why, if these gases are so poisonous, plumbers do not suffer. The answer is, that they do suffer frequently, and that they would much more often were they not, when exposed, in most cases in the full vigor of adult life and of health. Muhlenberg says that "if the vitality of a rabbit is lowered by the administration of phosphorus, micrococci, which under other circumstances do no harm, increase so rapidly as to be fatal."

This sufficiently explains the immunity which adults usually enjoy, and especially those who are most of the time away from home and in the open air.

Typhoid fever has long been known to be caused by sewer emanations. It is quite true that this is not its only source, but it is probable that in all large cities, where sewer-pipes are connected with the houses, sewer-gas causes more typhoid fever than all other causes combined. In the country, also, and especially in the large hotels at fashionable watering-places, examples of sickness and death from this source are alarmingly frequent.

Diphtheria must be classed among the diseases which in all probability are, in many cases, caused or conveyed by sewer-gas. The testimony upon this point is so well-nigh conclusive that many medical men accept it as an established fact. For myself, I do not entertain a doubt upon the subject; and this is the opinion of Professor Willard Parker, as expressed at the Academy.

In the report of the Michigan State Board of Health for 1881 occurs the following passage:

> It is probable that the contagium of diphtheria may retain its virulence for some time, and be carried a long distance, in various substances and articles in which it may have found lodgment. Diphtheria contracted from germs carried several blocks in a sewer may perhaps be as fatal as when contracted by direct exposure to one sick with it. While it is not definitely proved that the germs of diphtheria are propagated in any substance outside the living human or animal body, it is possible that they may be found to be thus propagated.

Dr. Janeway, addressing the Academy, said:

> It is hard to distinguish between sickness from sewer-gas and sickness caused by noxious disease-germs conveyed in the sewers. Small-pox may come from germs in the sewers, but no one would attribute it to sewer-gas. In regard to diphtheria, however, it is less plain. The portability of diphtheritic poison is greater than is supposed.

Scarlatina.—Professor Barker declared to the Academy that sewer-gas malaria had often, in his experience, been found to complicate scarlatina, and render fatal an attack which might otherwise have ended in recovery.

Dr. Alfred Carpenter, of London, a well-known physician and sanitarian, has in a paper of considerable length, published in "The Sanitary Record," London, for March 15, 1882, related many examples in which scarlatina was propagated, perpetuated, and intensified by sewer-gas; the result of his careful observations being that in many cases, in order to render the scarlatinous germs which came through the sewers capable of successful inoculation, the patients need to have been exposed for some time to the debilitating influences of the sewer-gas; in other words, as he affirms, a suitable soil must have been created in these persons. In a letter addressed to me, dated Duppas

House, Croydon, June 5, 1882, he says: "I have abundance of evidence that scarlatina is distributed by sewers, or rather that the germs which grow it are conveyed with sewer-air. If, however, the constitution of those receiving the germ is not fitted to grow it and to lead to its fructification, no fever will arise, and the germs will abort. It will not develop in ordinary flesh and blood, but requires that the recipient should be in a special state as regards his own blood to enable it to mature."

In addition to the evidence now presented, and which might be greatly multiplied, as to the probability, or, as perhaps most physicians think, the certainty, that typhoid fever, diphtheria, and scarlatina are thus caused or distributed from house to house, there is the negative testimony presented in the fact that these three terrible maladies are seldom seen in those Eastern Asiatic cities where "modern improvements" in plumbing are unknown, and that with us they have increased just in proportion to the extension of these "improvements."

It is quite probable, if not actually demonstrated, that Asiatic cholera is often propagated in the same manner. The length of time its germs survive after being thrown off from the body, and the established fact that the excreta are known to contain and convey the germs, increase the presumption that it may be distributed by the sewers, if indeed it does not render it absolutely certain.

Finally, no good reason can be given why every zymotic disease may not in this manner, at certain times and under certain circumstances, be widely distributed, although no doubt the liability of such distribution must depend much upon the viability of the germs and upon other circumstances.

What are the practical difficulties in the exclusion of sewer-gas where plumbing is extensively distributed through our dwelling-houses; and is there at present any ground of encouragement that they will be overcome?

The Water-Traps.—Professor Doremus illustrated to the Academy by experiment that gases would pass through water in water-traps, although there was free ventilation on the opposite side.

The applicability of these experiments to the question of the passage of sewer-gas and bacteria through water-traps has by some been denied, and especially on the testimony of the experiments of Carmichael, of Glasgow, in which experiments sewer-gases passed through well-sealed and ventilated water-traps in only a small amount, and bacteria were excluded altogether.

I am not a chemist, and this question I prefer to leave with those who are alone competent to decide it.

Some experimenters, however, have not obtained the same results as were obtained by Carmichael, Dr. Billings, and others. R. S. G. Paton, Ph. D., Chemist to the Health Department, city of Chicago, having made a series of careful experiments, assisted by B. W. Thomas, President of the State Microscopical Society, and in the presence of O. C. De Wolf, M. D., Commissioner of Health for that city, they have given it as their concurrent opinion that, as at present constructed, water-traps do not prevent the passage of "disease-germs" into our houses. Dr. De Wolf takes pains to especially emphasize the fact of "the readiness with which organic germs pass through the water of a sewer-trap and are thrown off from the free surface into the atmosphere of a room." (See "Report of the Health Department, City of Chicago, April 15, 1881.")

But, although I can not speak as an expert in this matter, it will be permitted me to say that there seems no reason, even if other and conflicting experiments had not been made, why the experiments of Carmichael should be regarded as conclusive. That unwholesome gases did not pass through well-sealed and ventilated traps, at a certain time and under certain circumstances, in sufficient quantity to imperil life, and that organic germs were excluded wholly, furnishes no conclusive evidence that they might not pass through at another time and under other circumstances. The amount of vapor, air, and gas contained in the sewers is greater at one time than at another. Their elasticity and tendency to escape are varied according to the nature and amount of the gases generated ; according to the temperature, which is changed continually where pipes are in use by the alternate flow of hot and cold water ; and according as the gases are moved upward with more or less force by the direction and strength of the aërial currents through the drains. In our own city, and in other maritime cities, and upon the sea-coast generally, the action of the tides in obstructing the outflow, and thus driving the contents of the sewers back toward the houses where the pipes terminate, is often enormous, and such as, by the most ample provision for escape through ventilators, can not always prevent a sudden pressure upon the water-traps sufficient to displace their contents, or to force the gas through the water in the form of bubbles, or, finally, to increase the capacity of the water to receive the sewer-gas by absorption.

Muhlenberg says, "The *bacillus typhi* has been found in drinking-water"; and Dr. Janeway, addressing the Academy, said :

> Another point is the possibility that much of the typhoid fever does not come from breathing sewer-gas, but from drinking water containing the germs of disease, which have been drawn up into the water-pipes and are taken into the alimentary canal. In a case under my observation several children were sick in a large house. I turned the water on below, and then, turning it on above, the air was sucked into the pipes below. These faucets were over some drain-pipes connecting with closets where diphtheritic stools had been deposited, and the water above, which was subsequently drunk, was thus tainted. This occurs also where there is no trap, or where there is no direct communication with the sewer. In one institution over seventy children were taken with typhoid fever from this cause.

Indeed, that water, especially when not in motion, will absorb gases, including putrefactive and septic germs, is a well-established fact; and it is equally well established that germs will live and multiply in water, and that they will even, in some cases, survive the action of frost upon the water. Germs in a condition of extreme desiccation and apparently long dead will, on being treated with moisture, if other circumstances are favorable, become revivified and developed into their most perfect and active forms.

It being indisputable that germs may be absorbed by water, and that they may multiply in water, it seems irrational that they should not by evaporation, or by the means of minute bubbles generated by decomposition of organic matter in the water, or by agitation of the water, escape into the surrounding atmosphere.

Professor Kerr, in an address before the British Civil and Mechanical Engineers' Society, said:

> We know that gas is generated by the decomposition of the decaying matter in sewage when deposited, in however slight a degree, upon any interior surface. What followed? We know this gas has two qualities which are extremely obnoxious: one quality was that it ascended to the highest level by reason of deficient specific gravity; and the second quality was that when it reached the highest level it exercised a pressure, being an extremely elastic gas. He need scarcely point out the effect of these two considerations. When the sewer-gas (a most excellent name, without going into particulars as to whether it should be called gas or vapor; the name sewer-gas carried an idea of offensiveness which was extremely convenient) when the sewer-gas had reached the highest level, it exercised a powerful elastic pressure to force its way out, and succeeded in forcing its way. It got into the houses; and if there were no other grievance, there was this to complain of—that this pestiferous and poisonous gas forced its way from the sewers into our houses, and, of course, reached the vital organs of those who occupied them.

Must we, then, accept as final the experiments made by Dr. Carmichael, and perhaps a few other experimenters? May we safely conclude that the gases and germs contained in the sewers can be effectually excluded by water-traps? That well-sealed water-traps afford some protection can not be questioned; but the experiments of Carmichael seem to me far from having rendered it certain, or even probable, that they insure absolute safety.

The reader will observe, however, that, even if we admit that the experiments of Carmichael establish all that has been claimed for them, it is still none the less a fact that the water-traps give us no protection when they are empty or defective; and examples abound in the experience of almost every plumber, in which the traps are found empty, either in consequence of the direct pressure of the air from below, or of siphonage, or of leakage; the leakage being sometimes due to the erosive action of the gases, to which action the traps are especially exposed, and sometimes to cracks occasioned by contraction and expansion, resulting from the alternate admission of hot and cold water, to settling of the walls, floors, and fixtures. Sometimes, also, large holes are made in the traps or leaden pipes by rats. I have in my possession examples of all these varieties of defective traps, taken from some of the best houses in this city, and the existence of which defects was not suspected until disclosed by the plumber. The traps, to be effective, it is unnecessary to say, must be kept in perfect working order, for this is a dangerous door to be left ajar, even for one moment.

The complete protection of our houses against sewer-gas will not, however, be accomplished when a trap shall be invented which shall be liable to no accidents and shall never fail. The trap is a matter of small consideration compared with the whole amount of plumbing work, of which it constitutes only a fraction.

The Pipes.—Professor Doremus demonstrated at the Academy that gases would pass readily through brick and stone, and through unglazed earthenware, even, in one instance, against a resisting pressure of two and a half feet of water, and in another against the pressure of a column of mercury thirty inches in height. The experience of every practical plumber confirms these experiments. Gases escape more or less readily, also, through iron pipes.

Lead and iron pipes are subject to the erosive action of the gases, and of various reagents. They are also, like the traps, liable to be broken by the settling of walls, floors, and fixtures, and they are occasionally broken by their own weight. The leaden pipes may be eaten by rats; at the jointings, they are believed occasionally to be perforated by galvanic action. In nearly all these cases the holes are at first small, but frequently a large number of these small holes will be found at the same time in different portions of the plumbing. These are the minute perforations to which Dr. Billings probably referred when he said, "there is more danger from a pin-hole in a pipe than from the traps"; for, while it is true that a large proportion of the germs perish for want of a favorable soil, it is equally true that one germ of a malignant type, conveyed into a system fully prepared for its nutrition, is as fatal as a thousand. Cohn estimates that one bacterial rod, under favorable circumstances, will produce 281,500,000,000 in forty-eight hours; and that, were it not for the unfavorable circumstances incident to its situation, it would fill the ocean in five days. It is not impossible that this one "pin-hole" might admit the typical bacterium into a typical soil.

Mr. Charles F. Wingate, sanitary engineer, says:

Even the best plumbing will not last for ever, but needs attention. Leaks may occur to permit the admission of sewer-gas from drain-pipes due to defective castings, or to walls settling in houses built on made ground, or from the strain of the alternate expansion and contraction from hot water, or even from the forcing of lead joints by the pressure of steam discharged from manufactories into the public sewer.

A no less serious evil is the corrosion of lead traps or lead waste-pipes, particularly in old houses which have unventilated drains. This may be caused by the action of sewer-gas, so called, or from the use of certain popular disinfecting fluids.

Lengths of pipe have been found completely honey-combed in this way. As such corrosion usually occurs on the upper side of traps or horizontal pipes, it is not easy to detect their presence from the absence of leakage, and the only safeguard is to avoid carrying waste or soil pipes horizontally; also, to extend their upper ends through the roof, and leave them open for ventilation. Lastly, to substitute iron pipes for lead wherever possible, which is now the general rule in all good plumbing practice. . . . Corrosion sometimes occurs at the joints of lead pipes, contiguous to the line of solder, and is attributed to galvanic action created by the contact of the zinc and lead, but as these openings are apt to leak they are more liable to discovery.

It is a good plan to overhaul all plumbing periodically, say once every year or two, to guard against accidents. . . . And here it should be remarked that sewer-gas is created not in the sewers alone, but every inch of waste-pipe in a house, even though used to convey nothing but soapy water or the waste of melted ice from a refrigerator, can, and commonly does, produce foul gases. The worst odors are from just such sources, and they are certainly unwholesome.

Moreover, it must always be remembered that no plumber's work, however complete it may be at first, can be relied upon to remain perfect. ("Medical News and Abstract," November, 1881.)

Says Mr. Collins, in "The Sanitary Record," London, for March 15, 1882:

One hint more with regard to the house and its belongings, worth all the rest: Do not imagine that when structure, drainage, water-supply, and the various appliances appertaining thereto, are left in perfect condition, they will always remain so, and that, unlike every other production, they will last unimpaired for ever, or even that period of "for ever"—a few years.

The best plumbing will not, the experts say, last "for ever"; but, in order to render our houses perfectly safe, it ought to last as long as the house will last, for we can in no other way know when the danger is upon us. "It will not last that period of for ever—a few years," says Mr. Collins; and Mr. Wingate says it should be "overhauled every year to two, to guard against accidents." Mr. Wingate has told us what he means by "overhauling" the plumbing, when he said to the Academy that no inspection of the plumbing of a house was of value unless it was overhauled from top to bottom. In no other way could he give the occupant a guarantee that all was right; because, where one defect was found, the chances were that there were many. This, we are then given to understand, is what should be done "every year or two."

But we may be permitted to ask why the time should be fixed at a year or two? A leak might arise from any one of the many causes enumerated to-day, which did not exist yesterday. Why, then, "to guard against accidents," should not the plumbing be overhauled daily? Absolute security could only in this way be attained. The public is notified, therefore, not by the writer, but by professed sanitary experts, that in this matter the price of safety is eternal vigilance.

In searching for a remedy for defective plumbing and sewer-gas, the public is still further embarrassed by the fact that the several classes of professional experts, to whom it has been accustomed to look for instruction in matters pertaining to house sanitation, seem to have lost confidence in each other, and are heard constantly, and in the most public manner, charging each other with incapacity.

The chemists, apparently, are not agreed. The plumbers have been again and again charged with incompetency, and often with intentional dishonesty, by sanitary engineers, by physicians, and by the almost universal voice of the people, until to-day it is hard to find a man with sufficient courage to utter a word in their defense. "The sins of the plumbers" has become a proverb.

An architect, writing for the "The Architect," London, complains that, by eminent doctors, men of his calling have been "sat upon, blackguarded, lectured, blamed," etc., for their supposed ignorance of matters of this sort; and one gentleman, a sanitary engineer, has said, publicly, that there was "probably only one architect in this city competent to execute the specifications for the plumbing of large houses." The same gentleman did not hesitate to say to the Academy that physicians were regarded by plumbers as their "most wrong-headed customers," and as possessing only "a dangerous smattering" of knowledge upon the subject; the Academy was permitted, also, to understand that he entertained the same opinion; while a distinguished member of the National Board of Health said publicly that he could count upon his five fingers all the sanitary engineers in this country in whom he could place any degree of confidence.

If all that representative members of these several classes say of each other were true, the outlook would be very unpromising. There is, then, no class of professed artisans or scientists concerned in the business of plumbing, architecture, or house sanitation, who can be safely trusted.

It is believed, however, that there is some mistake as to the almost total incompetency of plumbers, architects, sanitary engineers, physicians, and chemists, to discuss and act upon these subjects intelligently. In short, as I have said before, "I am much more charitable to the plumbers and architects than are the public or the sanitary engineers. It seems to me quite probable that most of them are as competent and as honest in their special departments as any other class of citizens"; and I am pleased to see that, so far as the plumbers are concerned, the President of our City Board of Health entertains the same opinion, he having recently declared, according to "The Sanitary

Engineer," that they have more scientific knowledge than they are given credit for.

We ought, I think, to regard this mutual distrust and lack of confidence among these various classes as only another evidence of the overwhelming difficulties of the situation, and of the fact, so apparent to all, that we have been defeated in every direction. As, when an army of disciplined soldiers has been signally routed, the people begin to lose confidence in their officers, and the officers fall to charging each other with incompetency, neglect, and treason—so, also, in this case, these murmurs of complaint and of wide-spread dissatisfaction, these mutual criminations and recriminations, imply only a great failure, and not necessarily a dereliction on the part of any one concerned. The odds were against us; and this is what everybody will, sooner or later, come to understand.

The public need not lose confidence in either of these classes. Notwithstanding our present seeming antagonism, which may be due in part to a mutual misunderstanding, we are, as will be seen hereafter, converging steadily and rapidly to the same point. It will be found that we are practically united in our demand that plumbers, architects, sanitary engineers, and physicians, shall acquire more knowledge and skill than they now possess; and that where their united knowledge and skill fail to accomplish the end to which our efforts are at present directed, namely, the exclusion of sewer-gases from our houses, the people shall be urged at once to "to lop off superfluous luxuries"; instructing them also that, in exact proportion as their luxurious distribution of plumbing is diminished, their safety will be increased. They should be informed, at the same time, that, if they are compelled to submit to the presence of plumbing fixtures near their living apartments, they should follow the advice of Professor Doremus, and employ constantly and freely proper disinfectants, of which it is unscientific to say that they merely "disguise the bad odors"; for, if it be true that they do not cause directly the death of all germs, it is nevertheless true that they prevent putrefaction of organic matters, and thus destroy the aliment upon which the germs subsist, and by which they are enabled to multiply.

It would be unjust to say that plumbers, being interested in having the amount of plumbing extended, will be the last to limit its extension. So also, in a pecuniary point of view, are sanitary engineers and physicians interested. But no one, I am certain, will charge either of us with being influenced by such considerations.

Under the present system all that can be said is, that the united skill of the specialists has not, according to their own often-repeated declarations, and as every one knows, succeeded in rendering our houses safe against sewer-gas. We have, indeed, from one source and another, assurances that it can be done; but there is no proof, such as alone can be furnished by a sufficiently prolonged trial, that these assurances can be trusted. A generation has come and gone, thousands upon thousands have died, and looking at our decimated households we may well ask, How many more must be sacrificed to this terrible experiment?

The late rapid increase in the mortality of New York city has naturally caused wide-spread alarm. Last year 38,600 deaths were recorded, against 31,937 in 1880—an increase of twenty per cent. While the large additions to the city's population from emigration and other causes may account for some of this increase, it can hardly explain all of it.

Careful observers limit the increase in the population of New York to ten per cent, and estimate the mortality of last year as therefore ten per cent greater than during 1880. The percentage is just equal to the increase in deaths from contagious diseases.—(Charles F. Wingate, consulting sanitary engineer, "Practical Points about Plumbing," 1882.)

The writer proceeds to charge this increased mortality to the sanitary defects of our houses, especially in the matter of plumbing.

The death-rate of our city has continued to increase steadily since Mr. Wingate wrote. In 1880 it was 26·47 per 1,000; in 1881, 31·08; and for the two quarters of 1882, ending June 30th, the rate of mortality had increased to 31·11, with a prospect of a much higher rate for the year, inasmuch as, during two weeks of the month of July, the rate was higher than for the corresponding period of any previous year since 1872.

This increase of mortality has occurred notwithstanding the admitted fact that our streets are in a better condition than they have been for many years. It can not, therefore, be attributed to the unsanitary condition of the streets, as has been the usual practice of newspaper writers in previous years.

Nor does it seem proper to attribute it to our vicious tenement-house and apartment-house system, which, no doubt, has its effect in raising our death-rate, but which, according to the reports of our city officials, has in many respects been greatly improved during the last two or three years. Meanwhile, everywhere the plumbing, as it has become older, has necessarily become more imperfect.

A member of the Board of Health, for whose opinion I have great respect, has said to me, that "when we consider the unusual prevalence of contagious diseases, and the large amount of immigration during the first half of the present year, we must admit that sewer-gas alone can not account for the increase in the death-rate over last year." Perhaps not; but it will not be pretended that the deaths of immigrants will alone explain it; and as to contagious diseases, these are precisely those which, according to Mr. Wingate, Drs. Barker and Carpenter, with many others, are most likely to be multiplied and intensified, and thus rendered fatal by sewer-gas. The fact that the increased death-rate is chiefly due to the increase of contagious diseases justifies the suspicion that sewer-gas is, to a great degree, responsible for this result.

The President of our Board of Health is reported to have said that "there has been a similar increase, during the last two years, all over the world." It would be impossible to determine this fact, for the reason that a large portion of the world makes no record of death. Probably he said, or intended to say, that such was the fact in the large cities of the most civilized portions of the world; and inasmuch as this has not been a season of general epidemics, and there have been no marked meteorological conditions to which it might be ascribed, and in the absence of any other plausible explanation, it would be quite as fair to attribute it to an extension of "modern improvements" in plumbing as to anything else.

A system of sewerage for the city of Memphis, Tennessee, was commenced January 20, 1880, and completed July 1, 1881. When completed it was found that thirty-three miles of sewer-pipes had been laid, and three thousand five hundred and seventy-nine water-closets had been connected with the sewers. On comparing the mortuary records of the year preceding the completion of the work, and before the houses were connected with the sewers, with the year succeeding the completion, it appears that the mortality of the city has materially increased—although neither of these years was a year of epidemic. The deaths from typhoid fever were the same each year; but the deaths from dysentery were nearly doubled, and the deaths from diphtheria nearly quadrupled.

The "system" adopted is approved by many of our best sanitarians; but it was not carried out, in all respects, as recommended and agreed upon, and therefore may not be regarded as a fair test of the value of the peculiar system adopted. But we have the authority of the gentleman who claims to be its inventor, to the effect that "the drainage of houses and their connection with the sewers has been admirably carried out under strict regulations, faithfully executed," and that the system, so far as completed, is "an entire engineering success."

In view of the facts as above stated, there is a sort of grim humor in the letter of a "citizen of Memphis," who says, in confirmation of the value of the work already done, "Memphis is a redeemed city, and we are thinking of putting on airs, and advertising it as a summer resort."

It has already been intimated that those to whom the public has been accustomed to look for counsel upon this and allied subjects do not differ so widely as some have supposed, but that there is actually a very strong convergence of opinion as to what needs to be done.

Professor Willard Parker, one of our most distinguished physicians, after listening to the discussions of the Academy, said: "If I were to build a house, I would not have it connected in any way with a sewer. I would construct a sort of annex." Into which, Professor Parker was understood to say, he would gather all the pipes and fixtures, water-closets, baths, and wash-basins. He further remarked: "I suppose most of you would object to having a vault filled with dead bodies a few yards from your house, and connected with it by a pipe. Yet this is practically what we do. Water is no protection from the poisonous germs which generate and live in this foul air. This matter demands our most careful attention, for we are in a very critical and unhealthy condition."

Colonel George B. Waring, Jr., sanitary engineer, addressing the public through the daily press, gives the following advice: "Let us take no step backward in the essential improvement of the adjuncts of our daily life. Let us only *lop off luxurious superfluities*, and see that what is really needed is good. . . . There is no doubt that the luxury of a wide distribution of plumbing appliances throughout the whole house has led to a great increase of risk and to a wide distribution of dangerous defects. The use of stationary wash-basins in bedrooms not immediately adjoining soil-pipes is to be deprecated; and everything should be reduced to the simplest elements that will give the necessary sanitary control of the waste matters of the house."

Not long after Mr. Wingate had protested to the Academy against "the foolish fear which prevails regarding the risks to health from so-called modern improvements," declaring that there was no need of taking a step backward, a circular was received from the Heath House, Schooley's Mountain, New Jersey, containing a certificate from "Charles F. Wingate, consulting sanitary engineer," a portion of which reads as follows: "I found the plumbing fixtures all placed in an extension, so as to be completely isolated from the rest of the hotel, and with a free circulation of air around them. There are no basins in bedrooms. . . . In short, sanitary considerations seem to have been studied at every point, and this, I am sure, will have due weight with future guests."

It seems fair to assume that an arrangement which Mr. Wingate can conscientiously recommend as contributing to the health and safety of the guests of the Heath House he can conscientiously recommend also to the occupants of any other house, and especially to the occupants of city houses, where the danger from sewer-gas is tenfold greater than at the Heath House.

If I have interpreted their language correctly, one of these distinguished sanitary engineers is substantially in accord with Dr. Parker and myself, and the other is absolutely in accord; and these are the only sanitary engineers, so far as I am informed, who have publicly, and over their own signatures, taken exception to our views.

It seems, however, that the people themselves, without asking the opinions of sanitary engineers, or of any one else, have concluded, in many instances, to "lop off the luxuries," and to practically adopt the measures which I have suggested—these concessions on the part of civilization being subsequently indorsed and approved by both sanitarians and sanitary engineers. As has been seen, the proprietor of the Heath House, at his own instance, placed his plumbing fixtures in an annex.

C. and W. Leland, Jr., proprietors of the Ocean Hotel, Long Branch, announce that "none of the sleeping apartments have water, nor are they connected in any way with water or drainage pipes." Drs. Hunt and Hughes, recognized sanitary experts, have examined the premises, and certify that they regard the arrangements "as a sample of sanitary completeness." The same thing has been done in the lately added portion of one of the largest and most popular hotels in this city, namely, the Sturtevant House; and, about a year since, the Fifth Avenue Hotel "changed the pipe-basins of about fifty of its best rooms for basins with pitchers, to avoid any possibility of complaints on the score of sewer-gas."

Mr. George Harding, of Philadelphia, has erected a very large and elegant hotel on the Catskill Mountains—the "Hotel Kaaterskill"—which is said to have no rival in its construction and completeness, but in which there are no stationary basins, and the plumbing is confined to the rear end of the building.

A gentleman is now constructing a handsome residence in Fifth Avenue, and he informs me that, recognizing fully the danger from sewer-gas, he has placed all those fixtures which he proposes to use at the rear end of his house. He has, however, extended his plumbing throughout his house, because in the case of his death the house may be sold, and some might object to it if it did not contain all of the "modern improvements"; but he has made arrangements to cut off completely all of the plumbing except that which is in the rear of the house, and in this condition it will remain so long as it is occupied by his family.

Mr. John Honeyman, while defending architects from the charge of incapacity made by the doctors, says in the London "Architect," that they were "among the first to point out the dangers arising from the general introduction of water-closets."

"The Sanitary Engineer," describing the "sanitary appliances" in the elegant mansion of W. H. Vanderbilt, recently constructed in Fifth Avenue, says, "As for stationary wash-hand-basins, they are almost unknown, there being but two in the whole house—one in a dressing-room or retiring-room off the billiard-room, and one in a private bath-room."

Indeed, stationary basins are now excluded from many of the most fashionable hotels in the country, and, if I am correctly informed, from several public and private houses in this city which I have not mentioned; although most of them continue the more objectionable practice of having the water-closets in the same building with their guests and their families.

The "Medical Record" for July 8, 1882, contains a letter from Dr.

Joseph A. Andrews, dated at Hong-Kong, May 9, 1882, giving a description of Canton, "the most characteristic of Chinese towns," in which it is said, "No closed under-ground sewers or drains exist, save a rudely constructed gutter in the center of the street, which carries off the superfluous rain," etc. The contents of latrines are removed in open buckets, generally during the day. And notwithstanding these, with many other unquestionably unsanitary conditions, in a city containing a population of one million, situated in a warm climate, "there is no typhus, rarely typhoid, and none of the other diseases, diphtheria, etc., considered the inevitable consequence of defective sanitation."

Dr. Andrews adds :

The healthiness of the foreign population of Canton is certainly in a great measure owing to the absence of water-closets in the dwelling-houses, which at home are a fruitful source of disease. Sulphureted and carbureted hydrogen gases are evidently not so injurious to health when given off in the open air as when escaping from sewers. Canton, like the whole country, is a city of bad smells, and yet the people do not seem to suffer from them, but, on the contrary, rather like them. The removal of excreta and the disposal of sewer-water is the sanitary problem of the day at home and abread. Our sewers allow the transference of gases and organic molecules from house to house and from place to place. Occasionally, by bursting, leakage, or absorption, the ground is contaminated, and the water-supply is in danger of being contaminated and poisoned ; and all these dangers are greater from being concealed. In China, there is at least freedom from one of these dangers. *It would certainly seem advisable that our water-closets should be in a projection from the building, with a tube passing to the outer air.*

The italics are Dr. Andrews's.

Why did those in authority allow such defective sanitary arrangements? was everywhere asked after the fever at Lord Londesborough's; and this question you heard repeated, regardless of the fact that sanitary arrangements, having such results in this and other cases, were themselves the outcome of appointed sanitary administrations, regardless of the fact that the authorized system had itself been the means of introducing foul gases into houses.*—("The Study of Sociology," by Herbert Spencer, p. 3, and note on p. 405.)

Finally, the writer wishes it to be understood that he recognizes the agency of many other conditions than the presence of sewer-gas in dwelling-houses in causing the increased death-rate of large cities ; but that, in what he has written, his chief purpose has been to place before his readers the careful observations of scientific and practical

* Of various testimonies to this, one of the most striking was that given by Mr. Charles Mayo, M.B., of New College, Oxford, who, having had to examine the drainage of Windsor, found that "in a previous visitation of typhoid fever the poorest and lowest part of the town had entirely escaped, while the epidemic had been very fatal in good houses. The difference was this, that while the better houses were all connected with the sewers, the poor part of the town had no drains, but made use of cesspools in the gardens. And this is by no means an isolated instance."

men, and to note their conclusions as to the probable responsibility of these agents. In most of the points considered his own opinions have been guided by and subordinated to theirs.

THE SCIENCE OF THE PRESENT PERIOD.*

By EMIL DU BOIS-REYMOND.

WHILE the memorial days of Frederick the Great and of Leibnitz turn the view of the Academy back to the times of its origin and of its new birth, this festival directs its vision upon the present.

Whoever, having a nature like that of an academician of the old school, prefers to live a contemplative life far from the tumult of the market and the strife of the forum, or even from the stimulating competition of the lecture-room, intent only on the accumulation of the treasures of knowledge, the solution of intellectual problems, the enlargement of his inner circle of thought, he might well at this period long for the undisturbed rest and the quieting gloom of a middle-age Benedictine cell. Happy monks of Monte Casino and of Montserrat! Concealed in the turbid wake of the people's flood, you looked down from your peaceful height upon the world, whose strife and anxieties troubled you not.

But the gates were opened, the walls fell long ago. The bright daylight casts an incongruous illumination upon the rubbish and dust of Faust's study-room. The inexorable to-day no longer allows a peaceful dream-life. We need no Mephistopheles to tempt us into an active career; we are seized with a thousand hands, some rude, some caressing, and the steam-horse instead of the enchanter's cloak is our servant. Our only trouble is to resist these calls, to keep our senses in the whirl that carries us along, to perform the outer work imposed upon us and still be true to the inner work which is our real calling. We can no longer, like our peers of old, freely follow our personal inclinations, only exercising the gifts which God has bestowed upon us. From childhood we belong to the state. Every condition of exemption has vanished. Examinations, military service, and the duties of citizenship, are common to all; and, while one ought not wholly to shun the duties of politics, he may regret the exaggerated prominence which its fruitless excitements, its ephemeral triumphs, and its sharp partisan strifes, have assumed in the culture-life of the day.

And how little quickening, in many respects, is this life of the latest fashion! The hydra of morbidly exaggerated patriotism raises

* Address delivered on the Emperor's birthday, in the Academy of Sciences, at Berlin, March 23, 1882.

head after head in its circle, and comes between the learned of different lands, who have hitherto felt themselves members of a single community. People who have done nothing for their fame except occasionally to stir themselves lustily, put themselves boastfully and contentiously into the fore-rank of those who have a thousand years of intellectual creation behind them. Instead of dynastic wars, we are threatened with incomparably more shocking race-wars, without the religious wars having ceased much otherwise than in name. Have not the last two years witnessed an agitation the shame of which we considered as unlikely to fall upon us as that of the rack, of trials for witchcraft, or of man-selling? With this, sentimental ignorance, whose well-meaning way can not be distinguished in its effect from slanderous accusation and vicious persecution, has dared to brand as mischievous methods of scientific research which Robert Hooke, in the bosom of the old Royal Society, and the God-fearing Haller, unquestionably used.

But even the later development of scientific life lets few distinguishing traits of itself be recognized. A persistent effort, devotedly directed toward ideal objects, has rarely been pursued to the end by the after-growing generation. A thousand busy workers, renouncing high fame, are daily bringing in a thousand details, unconcerned about inner and outer completeness, caring only to attract attention to themselves for the moment, and to gain the best price for their goods. Instead of honorable alliance, a reckless struggle for existence frequently prevails in a very odious form. The men of one party regard those of the other with the feelings of rival gold-diggers, but with less security, for a kind of law prevails in the diggings. Whoever in them acquires a rich claim is allowed to work it in security, without any other one forcing himself into partnership.

The stream of knowledge is continually dividing itself into more numerous and smaller rills, and there is danger of its getting lost in the sands and marshes. In the onward-pressing haste, every pause for survey or review seems lost time. With historical reflection passed away one of the most fruitful germs of greatness, Carlyle's hero-worship; with comprehensive survey, the possibility of comparing the different branches of science together, and of causing one to illustrate and fructify another. Instead of healthy generalization, the tendency to unrestrained speculation again prevails in Germany. Brought up in abhorrence of false philosophy, we have had to live to see that the generation following us, which we thought we had strictly schooled, is falling back into the faults from which the generation before us scornfully turned away.

Finally, the complaint is generally set up that the more munificently laboratories and seminaries are founded, the more richly means are poured out for scientific journeys and enterprises, the more indifferent do youth hold themselves toward the treasures and expenditures which might in our time, alas! have greatly benefited us; and the more rare are phenomena which surpass mediocrity.

To these dubious prognostications for science is added the view of the transformation of human life by the later development of industrial art, which is taking place on a far grander scale than that which was inspired by the discovery of America and the inventions of gunpowder and printing. The abundance of means and of forces brought into play by this agency reacts through innumerable concatenations on all circles and levels of society, and the final victory of utilitarianism, whose precepts, moreover, were always clear to the multitude, seems near.

Thus an evil time is foreboded for pure science, without any definite hope for an immediate turn of the wheel. It is about as if one lived in the midst of a gradual, constant, self-completing change, such as the earth used to suffer in primitive geological times, when, in the course of physical, geographical, and climatic alterations, one so-called period of creation gave way to another, and as if the past of the perishing creation fell to us. The academies would then represent, as it were, transitional forms between the earlier and the new creation, with the excuses for their existence growing continuously more doubtful, just as we may find examples of a similar character in the vegetable and animal kingdoms. In fact, one does not need an ear of extraordinary delicacy to hear the jealous questions: For what are those stiff figures in the midst of the rushing life-stream that does not regard them? Of what use is a golden book in the midst of the general Democritizing? or, to pronounce the catch-word of the times, why a ring of scholars? Such are the terms in which a modern Heraclite, an adept in that worldly wisdom culminating in pessimism, which is praised as the newest phase of German philosophy, might express himself to-day. We Berlin Academicians may, perhaps, be permitted to adhere to the optimism of our founder.

To judge correctly concerning the present position of science, of the single observer and the learned bodies, one must betake himself, as it were, to a height above the clatter of the individual combats, whence he can watch the course of the battle, the grouping of the advancing masses, the closing circle of victory, and the unfolding of the plan; and a modern popular contest is harder to view comprehensively than a Homeric skirmish. From a proper point of view is observed the comforting, exalting opposite of that which, only partially beheld and imperfectly comprehended in the narrower circle of vision, was before lamented. Never was science, remotely viewed, so rich in the sublimest generalizations. Never did it represent a more magnificent unity in its objects and its results. Never did it advance more rapidly, with a more definite consciousness of its purposes, and with mightier methods, and never did a more active co-operation exist between its different branches. And, finally, never had academies so evident a vocation, or did ours, at least, exercise a greater influence.

So unjust is the accusation that contemporary science is split up into details, that we have to go back to Newton's time to find an example of an enlargement of our theoretical conceptions, like that which was effected by the enunciation of the doctrines of the persistence of energy and motion, and of the mechanical theory of heat. As, at the former time, the fall of bodies, the motion of the stars, the refraction of light, capillarity, the ebb and flow of the tides, were recognized to be expressions of the same properties of matter, so now, through the labors of our generation of investigators, the same principle has been made to include the totality of the phenomena accessible to experiment, methodical observation, and calculation ; mechanics, acoustics, optics, the Proteus electricity, heat, and the elastic phenomena of the gases and steam. This principle is not merely, like universal gravity, an experimental proposition ; it conforms to the ultimate fundamental condition of our intellect. Hence its value as an aid to invention ; therefore it extends far beyond the limit of its strict verification. It permits us to weigh the ether and measure the atoms. The circulation of the waters over the earth, kept up by the force of the sun's light, falls under it as well as the circulation, similarly maintained, of matter through plants and animals. Forward and backward along the "corridors of time," as the Royal Astronomer of Ireland recently expressed himself in a sharp metaphor, it leads the way, and answers that very practical question for the thinker about the beginning and end of the world, with a reservation of the limits of error, as if we were dealing with measurements in the laboratory. The same wizard's-formula lends itself to practical instruction in the ordinary sense, and shows the machinist how he may reach a desired result in the shape of mechanical force, the electrical current, or light, with the smallest quantity of coal. Inorganic and organic chemistry, separated from the beginning, now find an all-ruling principle in the quantivalence of atoms.

As mechanics and physics discovered their guiding star in the persistence of energy, and chemistry in the theory of equivalents, so is the sphere of life composed by the theory of descent into a picture which brings within a single frame the immense abundance of forms of the present with the invisible traces of the most remote past. The ban of the Cuvierian theory, to which Johann Müller opposed himself, is broken. Instead of the lifeless system of the older schools, that Darwinian tree, in whose evergreen crown man himself is only a branch, waves before us. As zoölogical gardens and stations are to collections of animals, stuffed or preserved in alcohol, as botanical gardens to herbariums, so is the new knowledge of plants and animals, biology, to the older science. A development-history, as it were, of the transition of individual types from one into another, it leads back through paleontology and geology to the fiery-liquid youth of our planet, and hence extends its hand in the nebular hypothesis to the theory of the persistence of energy, while anthropology, ethnology, and the history of the primitive ages lay the bridge to linguistics, the theory of knowledge, and the historical sciences. The examination of the vital processes, physiology, has stripped off the larva-casing of vitalism, and has burst from its cocoon as applied physics and chemistry. While the physiologists of Germany during the first half of the century, and those of England and France in part till to-day, were engaged only with morphology, and at most with experiments on animals, for a generation past all the intellectual and instrumental aids of the physicist, all the arts of the chemist, have been naturalized in the physiological laboratory, and have been thereby much augmented. Nothing better illustrates the lively interworking of the different branches of science, at the present time, than that the investigation into original generation has helped surgery to the greatest progress it has made since Ambroise Paré, and pathology to a conception of the nature of the most destructive infectious disease, pulmonary tuberculosis.

Sciences, also, whose circles once hardly intersected, have approached each other. The triumph of the inductive method rendered historians and philologists like Thomas Buckle and Max Müller anxious to make themselves masters of its advantages, for it was evident that the difference between their activity and that of the naturalist was not fundamentally very great: of course not, for induction is, in practice, only sound reason sagaciously applied. To the interworking of archæological and scientific labors we owe a well-founded acquisition of recent times, the study of the primitive condition of mankind, created jointly by the Danish scholars Forchhammer, Steenstrup, Thomsen, and Worsaae, which is in many cases more interesting than real history.

It would be superfluous to extend the painting of this picture. We have given enough to show that the view that regards the science of the present as having been seduced into by-ways, and as being dissipated among special investigations definitely separated from each other, and that the notion that it is lacking in general ideas, that the wood can not be seen for the trees, are deceptive. It is, however, probable that no more such comprehensive theories as those of the persistence of energy and of descent will appear during the next decade, because a third theory of such moment is now hardly conceivable. We may therefore well repeat what Dove said, at about the middle of the last century, that "the impulse which science received in Newton's time, through the co-operation of his great talents, was not responded to by a proportionately rapid progress in the following period. Time was needed to elaborate the thoughts which had been so grandly aroused in the different fields, to adjust them in detail to the phenomena, to fill up the interior of the outlined scheme, which more accurate observations unfolded in continually increasing richness." Contemporaneously with the general thoughts requiring elaboration, have arisen such new methods of research as spectral analysis and chronoscopy, making possible conclusions that had not before been thought of. Not only have the world's trade—likewise greatly enlarged to beyond any extent which it had previously attained—and numerous scientific journeys contributed an overwhelming mass of new materials to the observing sciences, but an inexhaustible treasury has long been accessible to them at the zoölogical stations. The excavations methodically carried on unobtrusively, at different points of the old grounds of culture, are inundating antiquaries with a flood of discoveries, enough to engage the industry of generations.

What can be more desirable than for hosts of laborers, satisfying themselves with the solution of minute problems, to be occupying all the places with their restless activity? Why should there not be in the pursuit of science, as in a factory, men at the vise giving valuable service, even if they do not know what is to be done with the piece at which they are filing; foremen who know how to adjust the parts, yet are not informed as to the destination of the whole; and still further sighted, more deeply initiated masters? Art also laments the lack of prominent talent under the generally elevated condition of culture; aside from casual instances of the production of talent, it may be that we are only deceived through the unremarked gradation of so many fellow-workers. The superfluity of aids at our command naturally causes a depreciation of these workers, in accordance with the accepted law of the statics of the passions. Finally, if by the force of precarious social conditions there are not only absolutely but also relatively more young men to whom science is not the exalted, heavenly goddess, but a milch-cow, that is but a small matter to the great whole. In this, as in many other human affairs, ethical and æsthetical demands unfortunately concur only in the second line.

It all depends rather on the fact that something is accomplished, less on how it is done. The more industriously and at the more places anything is done from those motives, the more speedily does the apparent interruption pass off, and the more securely and broadly is the basis laid for new advances. It may be years or decades, the time will come when investigation will collect her energies, no longer scattered through a swarm of questions demanding priority of solution, for the attack upon the highest problems now before us: What is gravity? What is electricity? What is the mechanism of chemical combustion? And what is the constitution of the elements that have not been decomposed? It will solve them, for, the more definitely we set the limits of the knowledge of nature, the more securely can we build on the possibility of knowledge within those limits. Beyond those problems open others; and so again and again in the infinity of the periodic turns in the development-course of human knowledge.

The unparalleled spectacle to which Paris invited the civilized world last fall not only shows that science is exercising its binding force in spite of popular discords, but it at the same time teaches, better than all words, that, if the recent brilliant development of technics has dulled the taste for pure science, it has on the other hand compensated a thousand-fold for this injury. The electrical apparatus of thirty years ago filled a large room; that of to-day, generally illustrated by several specimens, filled a world's Exhibition-Building. Eilhard Mitscherlich has remarked of Herr Wiedeman's treatise on galvanism and electro-magnetism that nothing speaks more eloquently of the power of the human mind than that book filled with the clear facts which physicists have procured. Deep in thought we walked, keeping these words in mind, through the magic palace of the Elysian Fields, illuminated by the electric light, and ventilated by electrical machinery. We sometimes speak slightingly of Americanism, intimating that it bears utilitarianism on its shield. But who does not feel a patriotic pressure for old Europe at the wonders of the telephone and the phonograph? or at the report of the confirmation by Asaph Hall, with Alvah Clark's objective, of the discovery of the astronomers of Laputa? Hardly a year passes but that the newspapers report some new magnificent institution for purposes of pure science which American public spirit has called into life through private means, in a manner that is known on this side of the water only in England. The names of American historians, thinkers, and philologists are known along with the best, and are particularly dear to this Academy. We must accustom ourselves to the thought that, as the economical center of gravity of the civilized world lies already, like the center of gravity of a double star, between the old and the new continents, in the Atlantic ocean, so also will the scientific center of gravity in time move strongly toward the west. Enough: Europe may look out lest its science may be in more danger from the militarism which is forced upon it by the *chauvinsm* of all nationalities than American science from utilitarianism.

In one point, indeed, we may well reckon that leadership will not so soon be wrested from us. The co-operation of a body supported by the state, already fully composed into a permanent organization, representing in the highest possible degree the aggregate of knowledge, whose age and famous past give weight to its decisions, is a force not to be created overnight, even with the most ample means and efforts. Ingenious inventors, single though ever so worthy scholars and investigators, can not take the place of academies in the scientific life of a nation. It was a simple thing that the telephone should be discovered; remarkable that the explanation of it was reserved for members of our Academy.

At the time of their foundation the older academies entirely constituted the scientific world. In the universities, the so-called professional faculties had quite the upper hand over the philosophical, and in them classical philology predominated. The academies had intercourse with each other, but hardly exerted any influence on the outer world, which was strangely out of sympathy with them, except through their prize problems. Even in the comparatively idyllic conditions of the first half of the century, they limited themselves chiefly to the fulfillment of their inner calling, to their own scientific labors.

In view of the constant pressure of forces of every kind and degree, of the atomistic division of labor around us, of the unregulated assumptions, the short memory, of the overwhelmingly commonplace life of the present generation, the academies have an outer vocation in addition to their inner one. It is their duty to preserve the bond of connection in the division of labor, to have a look to the welfare of knowledge in the flight of the phenomena of the day. They should bring into competition with the dangerous enticements of technics, the charm of pure knowledge. Her sacred instrument, method, is in their care; but in Germany, where the false gods of perverted speculation are constantly finding willing Baal-servitors, it is especially incumbent on them to throw these idols out wherever they are smuggled in, and to drive away their priests. The necessary complement of an externally acting influence of the Academy is a no less vivid reaction from without upon the Academy, an interaction for the maintenance of which an alert organ, ready for the combat, is needed. The venerable but somewhat unwieldy form in which our body has comfortably moved for some tens of years could not satisfy such a demand of this "rapid, giddy-footed time." Our slowly and irregularly appearing "Monatsberichte," which were overwhelmed in the struggle for light and air with numerous active special journals, could not perform this service.

The Academy has, therefore, made some quite important changes in its arrangements and in the course of its business, which last year received the sanction of our immediate protector, his Majesty the Emperor and King. Among other things it has doubled the number of its class sittings, at the expense of the general meetings, and, in order to keep pace with the rise of new branches of science, it has quadrupled the number of its ordinary members. Following the time-honored example of its renowned sister of Paris, it has decided, not without opposition, on a kind of publication of its proceedings, which by means of weekly reports of meetings (*Sitzungsberichte*) shall satisfy the desire of members as well as of strangers for the most speedy information of its transactions. Our arrangement still leaves it possible to afford a place also for the former more complete and less urgent statements. The external appearance of the new "Berichte," and we hope its contents also, will be worthy of the first scientific body in the empire; and, in order to afford to the mathematico-scientific circle of readers the part of the substance of the reports most nearly interesting them in a more acceptable form, the Physico-mathematical Section has decided to prepare an extract from these reports under the title of "Mathematical and Scientific Communications."

Rarely do important and accessible questions, at least in natural science, now remain long unworked. The system of the putting of prize questions, and the coronation of the best answer, is therefore less adapted to our time than that of rewarding excellent, already published efforts, which is usual with the practical English. Partly on account of the tenor of the bequests to which the means for many of its prizes are due, partly for other reasons, the Academy has adhered essentially to the former way of awarding prizes. It will simply hereafter offer higher prizes at longer intervals, and it reserves the right, in case a prize question is not satisfactorily answered, to award the amount of the prize as a testimonial of honor to the author of a meritorious essay, not more than three years old, upon the same subject. It is determinative of the character of the Academy that it is under the protection of the state, and its authority is supported by that of the state so far as such a thing is conceivable and desirable in scientific matters. The state thus demonstrates the sympathy which it has with science, as such, with ideal efforts. It expresses this immediately by the means which it puts at the disposition of the Academy for scientific purposes. It has been too little recognized, amid the tumult of the great events of the time, that one of the first applications which the Prussian state made of its lately enlarged resources was to increase the annual subsidy of the Academy. Through the turn for the better thereby effected in the circumstances of the Academy were produced the works which now appear almost yearly on all branches of science with our support; the researches of all kinds, from epigraphic and diplomatic to micrographic and paleontological studies, for which we supply means; and the steamboat of the zöological station at Naples, the expense of which we share with the state. Around the Academy are crystallized several literary enterprises, the fame of which is reflected upon it, as well as endowments and institutes, whose resources accrue to its benefit so far as it has the more or less immediate disposition of them. Hardly ever are we without travelers who are making collections in remote parts of the world in our name and by our order, or interrogating Nature or the monuments of antiquity on the spot. The names of the travelers of the Humboldt *Stiftung*, to speak only of them, Hensel, Schweinfurth, Buchholtz, Hilderbrandt, Sachs, are in the mouths of all experts, and are associated with extremely important results. The Academy will shortly hear, in accordance with our new order of business, the reports which are now to be brought in concerning the progress of those investigaions and the work of a part of the societies and institutions associated with it. The opinion that its influence was never greater than at this moment will be fully confirmed by the creditable series of these reports.

The first of all the academies, that Platonic one of which Herr Curtius lately gave an eloquent sketch in this place, arose in a free state. Since its birth no republican commonwealth has brought forth a lasting and important work of the kind. According to M. de Candolle's statistics, Switzerland has, from the middle of the last to the middle of the present century, contributed, relatively, the largest contingent of the foreign and corresponding members of the Paris and Berlin Academies and of the Royal Society; it has itself not founded any academy. The origin of the Royal Society is lost in the storms of the Commonwealth; but it was not Cromwell's Puritans who prepared a place for human knowledge, and the name of the young society betrays the effort to lean upon monarchical institutions. That popular rule is not kindly to academies is shown by Bailly's and Lavoisier's bloody heads, and by Condorcet's sad end. Certainly there would be no place for the Academy in a social democratic state, which recognizes no principle but that of common utility.

Not only because in Prussia crown and state have always been one does our body, maintained, protected, and supported by the state, bear the title of royal with better right than many so-called learned societies. None of them have had so close relations to the ruling house. The Hohenzollerns' own peculiar creation, borne on the hands of Prussia's kings through good and evil times, the Berlin Academy has likewise numbered the greatest among its fellow-workers. Grateful expressions of thanks have often been given here for these recollections; to-day a word appears to be in place which it is our proud prerogative to speak.

To praise the Emperor William, as the victorious hero, the restorer of the empire of the German nation, the arbiter of the Continent, the mighty warrior and the real prince of peace, as one of the most remarkable figures described by history, is the task of others. It is for us to say, what finds but a slight echo in the world, but what signifies to the minds of those who are interested in affairs of the intellect another laurel-leaf in his crown, that in this culmination of his life, in the pressure of so important affairs of state, under the load of such consuming cares, in the grasp of such world-stirring questions, the Emperor William, true to the spirit of his house, has always had a friendly, open ear for his Academy of Sciences.

SOME CURIOUS VEGETABLE GROWTHS.

By W. H. LARRABEE.

THE importance of trees to the earth and to life does not need to be insisted upon. The condition of treeless regions is almost a demonstration that without them the soil would not be tillable and life would not be endurable. It is, therefore, natural that they should have at all times shared the special regards of men; and that not only particular species, but individual trees, should in their times and places have been hallowed with a sacred, historical, legendary, romantic, or mythical interest. The list of such trees, if one should undertake to make it out, would fill a large catalogue. Our own country and time, commonplace as their characteristics are supposed to be, are not without them. Other trees have become famous by reason of their extraordinary size, or some other remarkable features of their growth; and in these points we are able to present specimens with respectable claims to honor. The big trees of California are equaled among the trees of modern, and, so far as is known, of ancient, periods only by a few Australian eucalyptuses. Many of the most remarkable specimens of vegetable growth are familiar by description; others are added to the list, from time to time, as new quarters of the earth are more thoroughly explored and their forests more closely examined, or seen with eyes keener in observation.

The forests of Europe still contain a few remarkable trees, the history of which has not become trite by familiarity. Mr. Gaston Tissandier's "La Nature" furnishes us with descriptions and illustrations of two noteworthy specimens of these growths.

Switzerland has its old chestnut-trees on the banks of Lake Leman, and the ancient linden of Fribourg, the history of which is said to go back to the time of the conflicts with Charles the Bold. M. Louis Piré, President of the Royal Botanical Society of Belgium, has found a fir-tree in the forest of Alliaz, Canton of Vaud, which he believes to be still older than the linden of Fribourg, and considers entitled to be regarded as the oldest and most remarkable tree in the canton, if not in the whole confederation. It is growing near the baths of Alliaz, at a height of about thirteen hundred feet above the hotel, and forty-five hundred feet above the sea, surrounded by a forest of firs, which it overtops by more than thirty feet. The trunk of this tree is ten metres, or a little more than thirty feet, in circumference at the base. At about a yard from the ground it puts out, on the south side, seven offshoots, which have grown into trunks as strong and vigorous as those of the other trees in the forest. Bent and gnarled at the bottom, these side-trunks soon straighten themselves up and rise perpendicularly and parallel to the main stem. This feature is not, perhaps, wholly unparalleled, but another most curious fact is that the two largest of the side-trunks are connected with the principal stem by sub-quadrangular braces resembling girders. These beams have probably been formed by an anastomosing of branches,

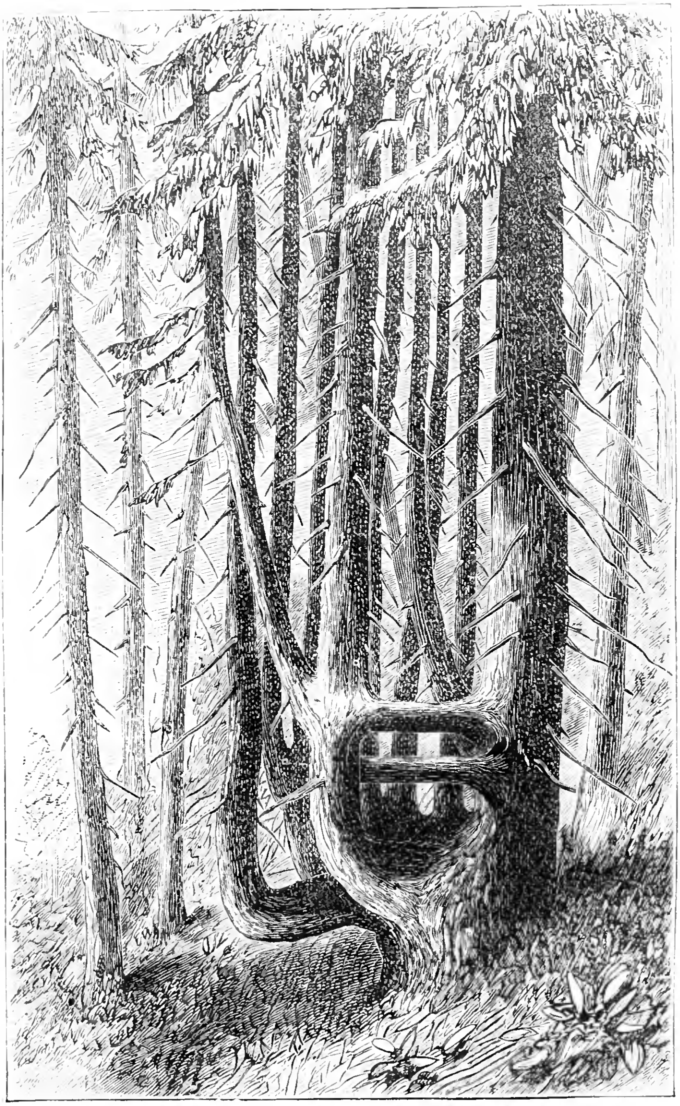


FIG. 1.—THE FIR-TREE OF ALLIAZ. (From a sketch by Madame A. Pire.)

which, common enough among angiosperms, is extremely rare among conifers; but it has been impossible to ascertain the manner in which the ingrowing of one branch into the other has been effected. The adaptation by which a limb, originally destined to grow free and bear foliage, has been converted into a living stick of timber, is a strange one, and affords a new illustration of the power of nature to fit itself to circumstances. The space between the rough flooring formed by the growing together of the offshoots, at their point of departure, and the girder-limbs, is large enough to admit of building a comfortable hermit's hut within it.

Several forests are still existing in Europe in a primitive condition, some of the principal ones of which are situated on the vast estates

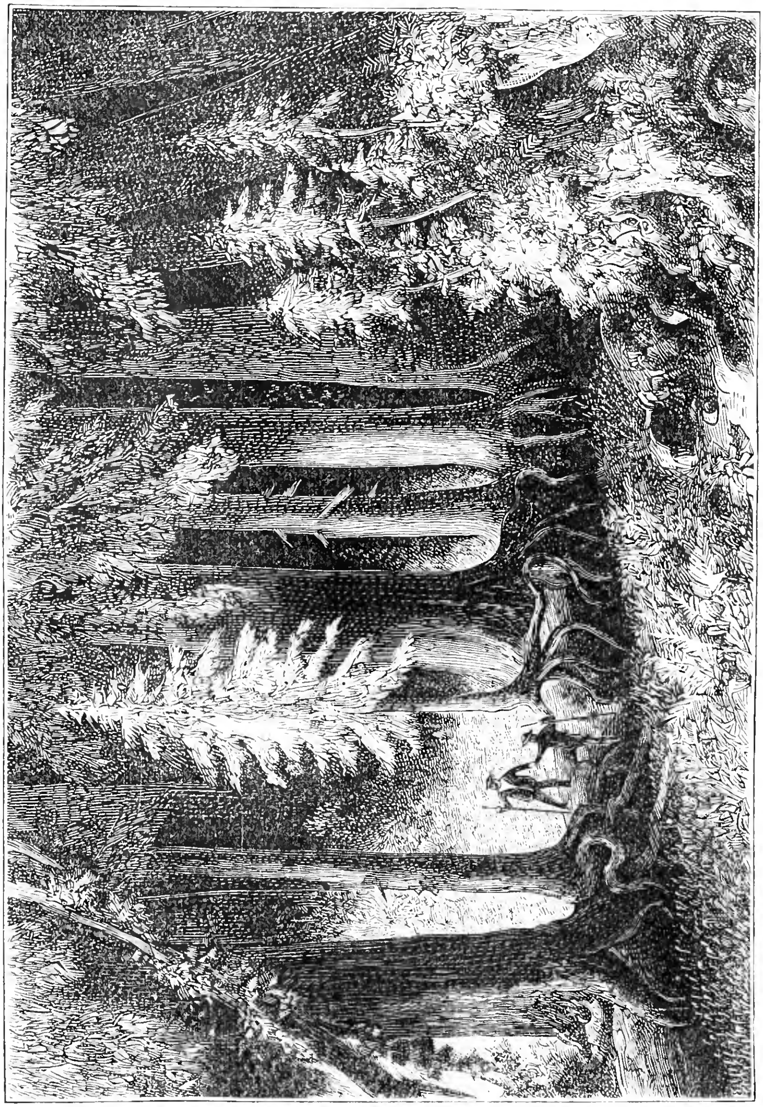


Fig. 2.—Extraordinary Growth of Pines in a Bohemian Forest.

of Prince Schwartzenberg, in Bohemia. In these forests are beech-trees a hundred to a hundred and twenty feet high, with trunks three or four feet in diameter; and pyramidal pines, four to eight feet in diameter, and towering to a height of from one hundred and twenty to two hundred feet. The dense foliage of these gigantic plants excludes the rays of the sun, and keeps all around them in impenetrable obscurity. The voices of the birds are hushed, and the silence of the solitude is broken only by the soughing of the wind through the foliage of the colossal trees. Old trees, which have fallen and decayed, furnish a rich and congenial base in which young larches and pines readily take root, and from which they may grow for centuries, drawing nourishment from the juices supplied from the slowly rotting trunk. This, at least, appears to be the case with the trees in our cut, which represents an actual group of trees growing upon the trunk of a fallen ancestor, some of which are nearly as large as the decaying monster itself, while that still keeps its shape.

Herr Haeckel, in the "Letters of Indian Travel" which he is publishing in the "Deutsche Rundschau," gives some glowing descriptions of the beautiful and curious forms of tropical vegetation which he met in the forests and jungles and gardens of Ceylon. Down in the valley away below him, as he journeyed by rail from Kandy to Peradenia, he observed in the jungles which alternate with the cultivated lands, towering above all the other trees, the giant stems of the talipat palm (*Corypha umbraculifera*), "queen among the palms of Ceylon." Its perfectly straight white trunk resembles a slender marble pillar, and often rises to a height of more than a hundred feet. Each one of the fan-shaped leaves of its stately crown covers a semicircle sixteen feet in diameter, or a surface of two hundred square feet. Numerous applications are made of the leaves, the most important, perhaps, being for purposes of thatching. They formerly constituted the only substitute which the Singlalese had for paper, and are still used to a considerable extent for that purpose. The ancient *puskola* manuscripts in the Buddhist cloisters were all written with iron styles on *ola*-paper, or narrow strips of talipat-leaves prepared by steeping and drying them. The talipat blooms but once in its life, generally between its fiftieth and eightieth year. The magnificent pyramid of flowers rises from the top immediately above the mass of the foliage, to a height of thirty or forty feet, and is composed of millions of little whitish yellow blossoms; and the tree dies as soon as the nuts are ripe.

On the road between Colombo and Point de Galle, although the general character of the landscape varied but little, the traveler's eye was never tired, for the constant charm of the cocoa and the inexhaustible variety in the grouping of the palms prevented any monotony. The delicately feathered leaves of the cocoas, with the fanning of the sea-breezes, tempered the heat of the sun, without excluding his rays.

The eye was constantly delighted with the endless variety of the clothing of the palm-stems with festoons of pepper-wort and other vines, swung like beautiful and artfully arranged garlands from tree-top to tree-top, and hanging down in bouquets of dense foliage set off with bright flowers. Under and among the stately palms were other trees, the noble mango and the large bread-fruit tree, with its thick, dark-green crown of leaves. The slender, pillar-like stem of the handsome papaya-tree (*Carica papaya*) was elegantly inlaid and adorned with a regular diadem of broad, palmated leaves; and jasmin, orange, and lemon trees in varieties were covered over and over with fragrant white blossoms.

As the road neared the sea-shore, the pandanus, or screw-trees (*Pandanus odoratissimus*), picturesquely growing upon the rocky hills, attracted attention. These are among the most remarkable and characteristic plants of the tropics. They are nearly allied to the palms, and are often called screw-palms, or, improperly, screw-pines. The cylindrical stem of this plant, which seldom reaches more than from twenty to forty feet in height, is bent and twisted, and its branches are forked like a chandelier. Each limb bears on the end a dense tuft of large, sword-shaped leaves, like those of the dracæna and the yucca. The leaves are sometimes sea-green, sometimes dark-green, and are arranged spirally at the base, so that the limb resembles a regularly turned screw. At the bases of the leaf-tufts hang clusters of white, extremely fragrant blossoms, or large red fruits like the anana. The most remarkable feature of the plant is afforded by the numerous air-roots which branch out from the trunk and ramify again, lower down, fastening themselves in the earth when they reach the ground, and forming buttresses to support the main stem. The tree looks as if it were walking on stilts.

The entrance to the Botanic Garden of Peradenia is through a noble avenue of India-rubber trees. This tree, which is known to us of the north only by puny specimens in greenhouses, grows in these tropical regions to a giant's stature, of a size comparable to that of our largest oaks. An immense crown of many thousand leaves covers with the aid of its horizontal limbs, which are thirty or forty feet long, the area of a stately palace; while from the base of its thick trunk extends a frame-work of roots over a space of often between one and two hundred feet in diameter, and much larger than would correspond with the height of the tree. This wonderful structure consists of twenty or thirty chief roots proceeding from as many corresponding ribs in the lower part of the trunk, and spreading themselves like great snakes on the ground. The tree is hence called the snake-tree by the natives, and has been compared by the poets to the coiled serpents of the Laocoön. The roots, with the ribs which mark their swelling out from the trunk, form strong buttresses to the tree, and enable it to bid defiance to the storm. The spaces between the buttresses constitute mimic chambers large enough for a standing man to conceal himself in them.

Among the other arboreal wonders of Peradenia are the giant bamboos, which are a marvel to all visitors. They here form thickets along the banks of the stream, a hundred feet high, and as many feet wide, bending their great heads, like the waving plume of a giant, high over the river and the adjoining road. On a nearer approach, each of the thickets is seen to consist of cylindrical stems a foot or two thick, which, closely crowded together below on a common root—offshoots from a creeping stem—diverge as they rise, and bear on slight, nodding branches dense tufts of the most delicate foliage. These gigantic trees are nothing but grasses. Like all grass-holms, their great hollow reed-stem is divided into joints; but the sheath of the leaf, which is represented in our tender grasses by a thin scale at the base of the leaves, becomes in these gigantic bamboos a hard, woody plate, that might without further preparation serve the purpose of an armor for the whole breast of a strong man. A three-year-old child could hide itself in one of the joints of the stem.

Not less interesting than the bamboos and the palms proper are the groups of thorny climbing palms, or rattans (calamus), with their fine waving feather-leaves. Their slender but hard and elastic stems, no thicker than one's finger, climb into the tops of the highest trees, and may reach a length of three or four hundred feet. They are the longest of all plants.

Herr Haeckel also speaks of the mangroves, whose branching roots form impenetrable thickets at the mouths of the large rivers; of the cactus-shaped wolf's-milk (*Euphorbia antiquorum*), with its naked blue-green prismatic limbs, near the rock-temple of Kaduwella; and of the Buddha-trees, Bogas, or sacred fig-trees (*Ficus religiosa*), generally found near the Buddhist temples, which with their venerable stems, fantastic roots, and colossal crowns of foliage, form a prominent feature in the picturesque surroundings of those buildings. "Their leaves, which are heart-shaped, with long stalks, quiver like our aspens." At one end of the town of Cultura, a magnificent banyan-tree (*Ficus Indica*) spans the road with its arch of roots. The gigantic trunk has thrown out air-roots which have grounded themselves on the opposite side of the road, and have grown up into large stems. These form now, together with the main stem, a high Gothic archway, to which picturesqueness is added by the ferns, orchids, and climbing vines that have grown upon the trunk. Near it is an India-rubber tree, whose buttressed roots, entwined together and rising in high lattices, form a labyrinth, in the sinuosities of which, when Haeckel visited the place, hosts of children were amusing themselves with playing at hide-and-seek.

Australia possesses a diversified flora, consisting partly of forms peculiarly its own, partly of those allied to African and South American

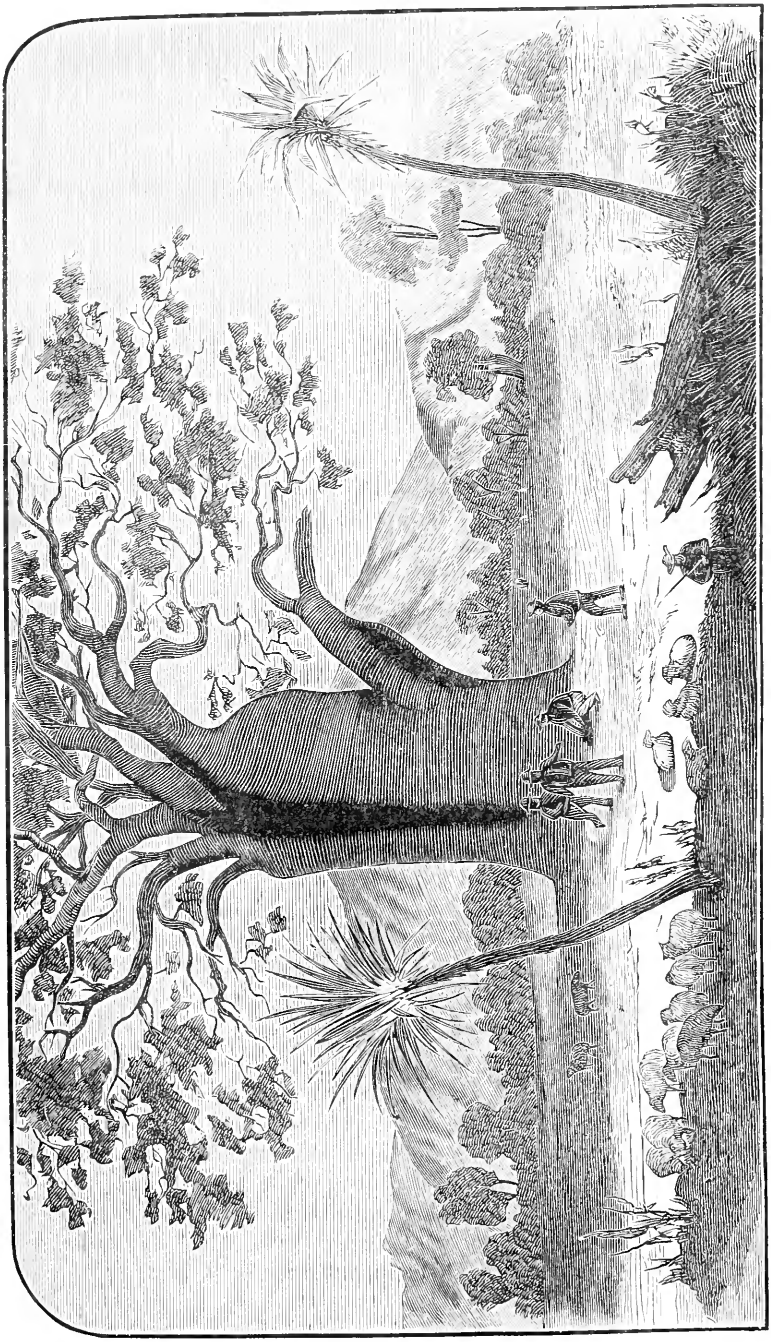


FIG. 3.—THE MONKEY-BREAD TREE (*Adansonia Gregorii*) OF AUSTRALIA.

types. Its myrtles, proteazeas, acacias, and gum-trees exhibit most curious forms, and the grasses, ferns, beeches, araucarias, screw-palms, and bananas are represented; while the thorny rattans wind among the thickets so as to form impenetrable copses.

One of the most curious trees of Northwestern Australia is the monkey-bread tree (*Adansonia Gregorii*), a baobab, which is plainly distinguished from the African baobab (*Adansonia digitata*), the only species hitherto known, by its short fruit-stalks. The trunk is swollen to a considerable extent, and the tissues are charged with a mucus like that of the mallows, of which the sheep feeding in the region are very fond, and which they find quite refreshing. The tree is remarkable, among its fellow-plants of the sandstone table-land on which it grows, for its habit of shedding its leaves periodically—a peculiarity which is shared by hardly a dozen among all the Australian trees. Associated with this baobab are relatives of other African plants, of the leguminous *Erythroplacum*, or poison-tree, and the tamarind; and to these may be added an ally of the Indian crow-nut, or *nux vomica*.

Many of the Australian plants exhibit various aberrations in the form of their leaves, with some of which specimens of their eucalyptus have made us acquainted. The acacias, which are very abundant, and appear in three hundred species, are many of them, as well as some other leguminous plants, distinctly marked from similar plants in Asia, Africa, and America, by having not veined leaves but phyllods, or leaf-like structures, in which the petiole becomes so much developed as to assume the appearance and perform the functions of a leaf.

Another remarkable adaptation of leaf-forms is exemplified in the Brazilian plant called the *Bauhinia*, the leaves of which are deeply cleft into two lobes, and given a form which is graphically described by the name *Unha de boi*, "ox-hoof," which the Portuguese give to the plant. At daybreak, the leaves are borne with both lobes spread out horizontally; as the sun rises in the sky, the lobes rise, and are drawn toward each other, till, in the more sensitive species (*Bauhinia Braziliensis*), they are completely doubled up, with their backs in contact. As the sun goes down, they begin to separate again, growing wider apart as the afternoon advances, till in the evening they appear again spread out level. During the night they again contract and become folded together. Herr Fritz Müller had an opportunity while in Brazil of observing one of these plants at noon, when a part of the leaves were shaded by the tree under which he was resting. Leaves that were quite closed together, or the lobes of which formed an acute angle with each other, spread out as soon as the shadow struck them, and eventually became horizontal, and even appeared to turn their lobes downward. In no other instance, however, did Herr Müller find the upper surface of the lobes of the leaves inclined to each other at a larger angle than 180°.

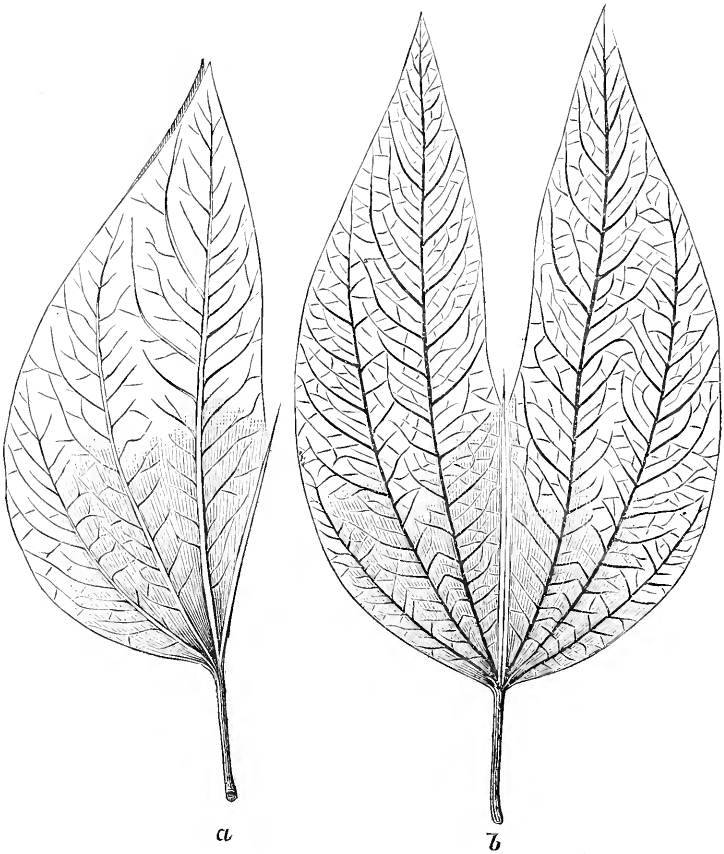


FIG. 4.—LEAF OF BAUHINIA BRAZILIENSIS. *a*, folded; *b*, expanded.

An American prairie plant, commonly known as the rosin-weed or turpentine-plant (*Silphium laciniatum*), has also been named the compass-plant, from the property its radical leaves have of pointing north and south. The phenomenon has long been known to hunters and frequenters of the prairies, and has been scientifically verified by General Benjamin Alford and other American and European observers since 1839. The secret of the property lies in the fact that the number of stomata is equal on both sides of the leaf, and both sides, therefore, are equally acted upon by light. Hence, if the leaf is equally exposed to the morning sun and the afternoon sun, it will naturally tend to assume a position of equilibrium between the two forces, by turning one side toward the morning, the other side toward the evening, sun. This would throw its breadth in a north-and-south direction. Since attention has been turned to this subject, the leaves of several other plants have been found to possess similar properties.

Among them are some *lactucas* (or lettuces), the Chinese *arbor vitæ*, and a number of Australian plants. Whenever this peculiarity has been observed, it has also been found, on examination, that both sides of the leaves were structurally alike. The property can be brought out clearly under favorable conditions ; but it is liable to be modified or marked, in the actual circumstances of growth, by any difference in exposure to the sun or wind, on different sides of the plant.

THE LAW OF HUMAN INCREASE.

By NATHAN ALLEN, M. D., LL. D.

IT is almost one hundred years since the attention of T. R. Malthus was first called to the subject of population and its changes. As his views have had more influence than any other writer, it is well to notice briefly what they were. His leading principle is, that "population, when unchecked, increases in a geometrical ratio, while subsistence increases only in an arithmetical ratio." He held that "population is necessarily limited by the means of subsistence," and "invariably increases where those means increase, unless prevented by some very powerful and obvious check." He divides these checks into two classes, the positive and the preventive : among the former are wars, famine, diseases of all kinds, unhealthy occupations, extreme poverty, great cities, etc. ; and in the latter class are abstinence from marriage and sexual intercourse, from considerations of prudence. The last class come more directly under the control of human agency.

The next writer of any note was Thomas Doubleday, who published in 1840 a work with this title : "The True Law of Population shown to be connected with the Food of the People." The term "true law" was undoubtedly introduced in opposition to the doctrine of Malthus. Doubleday attempted to demonstrate that "wherever a species or genus is endangered, a corresponding effort is invariably made by Nature for its preservation and continuance, by an increase of fecundity or fertility ; and that this especially takes place whenever such danger arises from a diminution of proper nourishment," and that consequently "the deplethoric state is favorable to fertility." Thus, "there is in all societies a constant increase going on among that portion of it which is the class worst supplied with food—in short, among the poorest."

The April number of the "Westminster Review" for 1852 contained an elaborate essay by Herbert Spencer, introducing a "New Theory of Population," deduced from the general law of animal fertility. He "maintained that an antagonism exists between individualism and reproduction ; that matter in its lower forms, for instance, of vegetables, possesses a stronger power of increase than in all higher forms; that the capacity of reproduction in animals is in an inverse ratio to their individuation; that the ability to maintain individual life and that of multiplication vary in the same manner also, and that this ability is measured by the development of the nervous system."

Fourier and some French writers have advanced the idea that "just in proportion as individuals become advanced in civilization, in the same proportion the race inclines to run out"; but whether this depends upon some change in physiological laws, or upon the influence of external agents, we are not informed. In establishing any law or general principle, it is highly important to understand distinctly what this principle is and its basis. During the present century, the above-named persons are almost the only writers who have proposed anything like a general law or principle to guide the growth and changes of population.

The principle laid down by Herbert Spencer is the only one based strictly upon physiology. All the discussions and views of Malthus and Doubleday depend mainly upon food, climate, government, state of society, epidemics, war, etc. They make the leading factors, the primary agents in all these changes, outside, and in a great measure independent, of the body. It would seem more consistent with common sense, and all natural phenomena, that the law which governs the existence, growth, and changes of a living being should have its basis and development in that same organization. From observation and analogy, we believe such a doctrine exists throughout the whole animal and vegetable creation. The truth of this principle is strikingly illustrated in the changes that have taken place in domestic animals. The human system can not be made an exception to a universal principle.

This law of increase or propagation—the most important of all laws—must, in the very nature of things, be inherent in the body; must be incorporated into its very existence, though in its operations it may be affected by extraneous causes and influences. However powerful may be the effect of climate, food, and other external agents upon the application or working of this law, whether to impede, thwart, or modify its operation, the law must exist, we believe, in the body itself, and in a great measure control it. The various changes to which the human body is subjected, can not happen by chance or accident; neither can the causes be dissimilar or contradictory in different nations and races; neither can they radically change or vary from one generation to another. Universality and unchangeableness must characterize such a law. The reason why correct principles have not been brought to bear more directly upon the growth and changes of population is, that the principles of physiology were not formerly understood. The science was scarcely known at the time when

Malthus and Doubleday published their works, that is, the principles of the science in many of their most practical applications. In fact, it may safely be said that some of these principles, as far as their application is concerned, are still in their infancy. One of the most interesting and important of these applications will be found, we believe, in establishing a general law of human increase.

After many years of study, observation, and reflection, we have been led to believe that there is such a law, and propose to submit some of the facts and arguments upon which this belief is based. As the subject is so vast and complicated, a large volume would be required to discuss it properly ; we can present here only a few points or heads of topics, by way of argument and illustration. In order to present a clear and connected view in a short paper, few quotations or references will be given.

What, then, is the briefest definition that can be given of this law? *It consists in the perfectionism of structure and harmony of function ;* or, in other words, that every organ in the body should be perfect in its structure, and that each should perform its legitimate function in harmony with all others. Though this perfect physical organization is nowhere to be found in nature, we can readily conceive of such a standard, and that there may be all manner of approximations toward it. The nearer this standard is reached, the more completely the law of propagation will be carried out. Such a basis harmonizes with the great fundamental or general laws of Nature, as we find that they are all based upon the highest or most perfect development of her works. Any other basis or lower standard would reflect upon the Creator of all things, and interfere with the harmony and order which exist in Nature's operations. Thus, in reference to every organ in the human body, there is such a thing as a normal, perfect structure, and, wherever this exists, they constitute a perfect model or standard for the whole system. All diseases interfere at once with the operations of this law, especially those that are considered hereditary. This class of diseases changes with each generation, and sometimes becomes so intensified that they impair the vitality and strength of the system to such an extent as to prevent propagation. There is a class of diseases or weaknesses, described under the head of "sterility," "barrenness," and "impotence," from which strong evidence may be deduced in proof of a general law of increase.

There is a law in physiology, favorable to this theory, described by Dr. Carpenter thus: "There is a certain antagonism between the nutritive and reproductive functions, the one being exercised at the expense of the other. The reproductive apparatus derives the materials of its operations through the nutritive system and its functions. If, therefore, it is in a state of excessive activity, it will necessarily draw off from the individual fabric some portion of aliment destined for its maintenance. It may be universally observed that, when the nutritive functions are particularly active in supporting the individual, the reproductive system is undeveloped, and *vice versa*."

Let, therefore, on this principle, any class of organs or any parts of the body be unduly or very much exercised, it requires the more nutrition to support them, thereby withdrawing what should go to other organs. In accordance with this physiological law, if any class of organs become predominant in their development, it conflicts with this great law of increase. In other words, if the organization is carried by successive generations to an extreme, that is, to a high nervous temperament—a predominance of the brain and nervous system—or, on the other hand, to a lymphatic temperament—a predominance of the mere animal nature—it operates unfavorably upon the increase of progeny. Accordingly, in the highest states of refinement, culture, and civilization of a people, the tendency has always been to run out in offspring ; while, on the other hand, all tribes and races sunk in the lowest stages of barbarism, and controlled principally by their animal nature, do not abound in offspring, and in the course of time they tend also to run out. The truth of both these statements is confirmed by history. The same general fact has been observed among all the abnormal classes, such as idiots, cretins, the insane, the blind, the deaf and dumb, and to some extent, with extreme or abnormal organizations, such as are excessively corpulent or spare, as well as of unnatural size, either very large or diminutively small.

It would seem that Nature herself is bound to put an end to organizations that are monstrous, that are defective, and abnormal or unnatural or imperfect in any respect. All history, we believe, proves that such organizations are not prolific in offspring, and the number of this class born into the world, reaching an advanced age, is comparatively not large. Such facts would indicate that there must be a general law of propagation that aims at a higher or more perfect standard.

If this principle is applied to distinct classes in society, some striking illustrations may be obtained. Take the families belonging to the nobility, the aristocracy, or the most select circles, where by inheritance, refinement, and culture the nervous temperament has become very predominant, it is found that such families do not increase from generation to generation in offspring, and not unfrequently, in time, they become extinct.

A similar result has also followed the intermarriage of relations, from the fact that the same weaknesses or predispositions are intensified by this alliance. On the other hand, in case these relations have healthy, well-balanced organizations—it may be that they are cousins—they will abound with healthy offspring, and the stock may improve, and not deteriorate, from the mere fact of relationship.

Again, if we take those families and races which for several generations have steadily increased most, we shall find that, as a whole, they possess a remarkably healthy, well-balanced organization. Illustrations of this type we shall find abound most among the middling or working classes of the German, the English, the Scotch, the Irish, and the Americans. The strictly native New-Englanders are, in some respects, an exception, and require a more particular notice. During the last century the colonists of New England, made up mostly of English stock, multiplied rapidly. So great was their natural increase that they doubled in numbers in less than twenty-five years. Malthus regarded them as the best specimens, in this respect, of any people or race, and based upon facts from this source his great principle of population. But a most surprising change has taken place within one hundred years with this same people. From records carefully kept, it appears that the average number of children to each family has decreased with every generation ; that they commenced with large families—averaging eight or nine—but it is now doubtful whether the average will exceed three children to a family, scarcely enough to keep the original stock good in numbers. This change has occurred in the same places, with the same people, having the same climate and plenty of food. Making allowance for the "arts of destruction and prevention" which may exist to some extent, we do not see how this great decrease in birth-rate can be accounted for, except by some change in physical organization. The first settlers of New England were remarkably healthy—had well-balanced organizations—and this fact was true of the women as well as of the men. But a great change in this respect has taken place. The men are not so strong and vigorous as their grandfathers and ancestors, and the women have deteriorated physically in a surprising degree. A majority of them have a predominance of nerve-tissue, with weak muscles and digestive organs. The most marked change in this one hundred years, in organization, is this loss of balance or harmony in the organs, and especially in women it is far more striking. They have been diverging more and more from that normal standard upon which the law of propagation is based.

There is only one other people or race where there has been such a natural decrease in numbers—that is the Sandwich-Islanders. Once they were a strong and robust people. In 1830, when the first census was taken—which was ten years after the American missionaries commenced their labors—the population was 130,000, but by the last census there were only about 40,000, one third as many as fifty years ago. In the mean time religious institutions have been introduced, education has become general, and the family as an institution has been established. All the elements of a Christian civilization have been thoroughly established, but still the population has been steadily decreasing at the rate of about one thousand each year. How can this be explained? It can not be from the want of food, nor a well-regulated society, nor change in climate, nor want of a good government ; there have been no wars, no famine, and only two or three epidemics, which were quite limited. The cause of this loss of population can not arise from any external condition or agents, but from some law growing out of and governing the physical system. It is well known that certain diseases, resulting from licentiousness and intemperance, have been brought by foreigners to these islands, causing a physical degeneracy in the people. So powerful and far-reaching are the effects of these diseases that neither the family, nor education, nor Christianity, can eradicate them. The law of propagation has been violated to such an extent that it threatens the extinction of that people.

The laws of hereditary descent afford strong evidence in favor of some general law of propagation. The fact that "like begets like," subject to certain variations and conditions, can not be called in question. The union of two agents, possessing similar and dissimilar qualities, constitutes an important condition to which this law of propagation is subject. While it may be difficult to point out, in all cases, the exact results of hereditary influences, still it has been demonstrated on a large scale that, in the aggregate, there was the most unquestionable evidence of such agency, and that it was minute and extensive, and continued for successive generations. Now, the same evidence that proves the existence of hereditary agency, implies that there is somewhere a general law, of which each and every part of this agency is part and parcel ; and no one thing will throw so much light upon this whole subject of inheritance as the recognition of a general law of propagation, based upon a perfect standard in nature. Without such acknowledgment, all these hereditary agencies are an enigma. When this branch of physiology becomes thoroughly understood, hereditary influences will more readily be traced back to their primary sources, as well as to the secondary causes which serve at times to change and modify them. In this case, far more intelligent and efficient means will be employed to improve the race.

Again : powerful arguments in favor of this theory of increase may be deduced from woman's organization. It is a settled fact that the primary organism of her nature is the production of children—that by this course her average health is better, and the mean duration of life is longer. Hence there must be one type or standard of organization better adapted for this purpose than all others. We maintain that the perfect structure of her whole body and the harmony of function in every organ constitute this normal standard of increase. The truth of this assertion, we believe, can be demonstrated from four distinct points—all most intimately connected with human increase : 1. In case of pregnancy a woman with this organization suffers the least. It is well known that this change frequently brings on many complaints, and sometimes serious diseases. The more the body or certain organs deviate from the normal standard, the greater the disturbance and suffering. 2. At the time of confinement, or in the process of delivery, a woman with this organization suffers less—passes through all its stages safer, and recovers from its effects quicker and better—than those having any kind of a different organization. 3. In the matter of nursing offspring, which constitutes a very important part of child-bearing, this healthy, well-balanced organization is very necessary. The fact that only about one half of the New England women can properly nurse their offspring is very significant of some change of organization—that there is a failure in the development of the mammary glands and the requisite power of the digestive organs—and this incapacity for nursing is constantly increasing. And, in the fourth place, the difference in the physical character of offspring is very significant. This is determined in a great measure by that of the mother. The more healthy and perfect her organization, and the better the balance of all her organs, the sounder and the more perfect will be the development of her offspring. The health and life of the child demand it.

This theory of human increase derives strong evidence from an analogous law in the animal and vegetable kingdoms. It is well known that great improvements have been made within the present century in domestic animals, and this, too, by the application of physiological laws. To such an extent have the results of observation and experiment been here carried, that this process of change and improvement has been reduced almost to a science. The terms here used—"pure blood," "thorough-bred," "pedigree," "breeding in-and-in," and "cross-breeding"—may all be explained by two great leading principles. One is a general law of propagation, based upon a perfect standard; and the other is the law of inheritance, subject to certain conditions. The three first-named terms have originated more from an observance or carrying out the first law—breeding from the best stock; but the two latter terms depend more upon the effects of inheritance. The results of the experiments in improving domestic stock indicate clearly that there must be some settled rules or laws in the process; and, if so, is there not some great general law governing and controlling all others? A similar law of propagation exists in vegetable physiology. It is a fact well attested by gardeners that, in order to produce flowers and fruit, the soil must not be too rich nor too poor; if the plant or tree grows too luxuriously, its branches or roots must be pruned; while, on the other hand, if unthrifty, it must receive better culture and its roots be enriched before it will become fruitful. It is well understood by gardeners that, in order to raise the best fruit and vegetables, the fairest and best-looking seed must be selected. So in setting out plants and trees the best-looking and well-balanced specimens are always selected. Other facts and illustrations might be cited from this source to prove that some general law governed in the growth and changes of organic life.

Again, arguments in favor of a general law of increase may be deduced from three other important points in physiology. Where do we find the highest measure or the most perfect health? It is in this same normal standard of physiology, and the nearest approaches to it. In some respects the human body resembles a complicated machine: the more perfect the structure, and the more nicely adjusted are all the parts of the machinery, the less likely is any one part to get out of order. And when one part, however small it may be, gives out or breaks, it at once involves the other parts, all of which must more or less suffer. Thus the individual, the family, the people which possess by nature the soundest and best-balanced organizations, will have, other things being equal, the greatest aggregate amount of health. Not only this, but they will secure the longest lives. This same standard of physiology, then, affords the material upon which the law of longevity is based. A careful examination of the organization of all those persons who reach a great age, we believe, will demonstrate that they naturally possessed a remarkably healthy and evenly balanced constitution.

Again, whenever physical standards of human excellence or models of the best specimens of the race have been sought or adduced, they have exhibited this harmonious development. The Apollo Belvedere and the Venus de' Medici represent a beautiful symmetrical organization; and, the nearer all parts of the body approximate to this standard, the greater is the attraction and the more beautiful the form. If there is a form or type of organization in the human species more beautiful than any other, is not this the model, the standard? We believe the Creator of all things has established in physiology such a standard of taste and beauty, and that this same normal standard, upon which the law of increase is based, comprises that beautiful form or standard of taste for the human body which, it has been admitted, existed, but is nowhere well defined.

Again, arguments in favor of this theory of increase may be deduced from the writings of Charles Darwin. Two of his leading doctrines are "natural selection" and the "law of variability." The former doctrine may be defined thus: There is an inherent principle in nature, amid all its laws and changes, for betterment, for improvement. The same result has been found out from long experience, that the character of domestic animals can be improved by selecting the most desirable qualities and by avoiding all that conflict with these. This principle is most strikingly manifested in all organic beings in their constant "struggle for existence," and is happily expressed in the phrase often used by some writers, the "survival of the fittest." We believe this same principle not only harmonizes with, but is nothing more nor less than a great general law of increase, based upon the perfectionism of all organization and harmony of function; and what are denominated "laws of variation" may be explained by the laws of hereditary descent. When we take into consideration the fact that the true law of propagation is based upon a perfect standard in nature, all changes or deviations from that standard or model result from what are properly called laws of inheritance. With this explanation it will be seen at once that a wide and varied field is laid open for their operations, dependent not only on the body itself, but upon external agencies and conditions. But the question arises, Why this "natural selection," why this "struggle for existence," and why the "survival of the fittest"? Do they not arise from a universal law in nature which gives to those possessing this organization in the highest degree the advantage over others?

What is this inherent principle in nature ever aspiring for betterment or improvement? What are the secret forces everywhere predisposing in this direction? Is there not some general, universal law incorporated into organic life which favors such qualities? As this law is primarily based upon a higher or perfect standard, all its inherent or predisposing forces have an upward or improving tendency. Thus all who are so fortunate as to possess an organization of higher grade or better than others have certain advantages. In this way the doctrine of natural selection may be readily understood and the survival of the fittest.

This general law, applicable to all organic beings, resembles in some respects that principle found in the human system called *vis medicatrix*. It was early discovered by physicians that in case any part or organ in the body became injured or diseased there was a surprising recuperative power in nature of healing or curing. All the sound parts of the body seem to conspire together to help the part or organ affected. This influence to assist seems spontaneous and always healthful. So it is with this law of propagation—it is not only conservative, but improving to all possessing more than an average share of the inherent forces of this law.

Connected with this law of population there are several points worthy of most careful consideration. While it possesses a sure and permanent foundation, there are a flexibility, an elasticity, which are self-regulating, and display a divine wisdom and power. Such is the nature of this law that, in all its varied operations, it does not interfere with the choice and free agency of man. When the character of this law is fully understood, what on the one hand are the penalties attached to the violation of any part of it, and, on the other hand, what are the rewards for its observance, it presents to man the strongest possible motives for his own improvement and the advancement of human happiness generally. If man is created a free moral agent, accountable for all his acts, the law providing for the propagating of the species should certainly be of such a character that he can clearly understand its nature and sanctions. According to those theories on population where its increase and changes depend mainly upon external agents, man is made, in a great measure, a mere passive agent, having but little control or responsibility in all those important matters.

If the theory here advanced is the true law of human increase, it is not a mere theory or an abstract general principle, but is capable of almost endless application, far more than can be enumerated. It will enable us to understand far better the nature of man, his duties and responsibilities in relation to himself, to the family, to society at large, and particularly to his Maker. It will furnish us a guide or great principle by which certain practices and fashions in society, certain modes of education, systems of morals, acts of legislation, etc., can be tested. It will throw new light upon what constitutes the true grounds of human progress and the real sources of an advancing civilization.

In closing this paper, it may be proper to state briefly what are the elements, or what is understood to constitute this law of population. *It is based upon a perfect development of all the organs of the human body, so that there shall be a perfect harmony in the performance of all their respective functions.* It presupposes that other conditions are favorable, such as the age, the union, and the adaptation of the married parties—provided no natural laws are violated or interfered with—there will uniformly be found with such an organization, not only the greatest number of children, but they will be endowed with the highest amount of physical vigor, strength, and health. We should also expect the best development of all parts of the brain, giving balance and symmetry to all mental qualities, whether social, intellectual, or moral. It should be further added that, inasmuch as perfect standards are not found, the nearer this normal standard of physiology is approached by all parties concerned, the more complete will be found the fulfillment of this law.

SCIENCE IN RELATION TO THE ARTS.*

By C. WILLIAM SIEMENS, F. R. S.

IN venturing to address the British Association from this chair, I feel that I have taken upon myself a task involving very serious responsibility. The Association has for half a century fulfilled the important mission of drawing together, once every year, scientists from all parts of the country for the purpose of discussing questions of mutual interest, and of cultivating those personal relations which aid so powerfully in harmonizing views, and in stimulating concerted action for the advancement of science.

A sad event casts a shadow over our gathering. While still mourning the irreparable loss science had sustained in the person of Charles

* Presidential Address, delivered at the Fifty-ninth Annual Meeting of the British Association, held at Southampton, August 23, 1882.

Darwin, whose bold conceptions, patient labor, and genial mind made him almost a type of unsurpassed excellence, telegraphic news reached Cambridge, just a month ago, to the effect that our Honorary Secretary, Professor F. M. Balfour, had lost his life during an attempted ascent of the Aiguille Blanche de Penteret. Although only thirty years of age, few men have won distinction so rapidly and so deservedly. After attending the lectures of Michael Foster, he completed his studies of biology under Dr. Anton Dohrn at the Zoölogical Station of Naples in 1875. In 1878 he was elected a Fellow, and in November last a member of Council of the Royal Society, when he was also awarded one of the Royal Medals for his embryological researches. Within a short interval of time Glasgow University conferred on him their honorary degree of LL. D., he was elected President of the Cambridge Philosophical Society, and, after having declined very tempting offers from the Universities of Oxford and Edinburgh, he accepted a professorship of Animal Morphology created for him by his own university. Few men could have borne without hurt such a stream of honorable distinctions, but in young Balfour genius and independence of thought were happily blended with industry and personal modesty; these won for him the friendship, esteem, and admiration of all who knew him.

Since the days of the first meeting of the Association in York in 1831, great changes have taken place in the means at our disposal for exchanging views, either personally or through the medium of type. The creation of the railway system has enabled congenial minds to attend frequent meetings of those special societies which have sprung into existence since the foundation of the British Association, among which I need only name here the Physical, Geographical, Meteorological, Anthropological, and Linnæan, cultivating abstract science, and the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, the Society of Telegraph Engineers and Electricians, the Gas Institute, the Sanitary Institute, and the Society of Chemical Industry, representing applied science. These meet at frequent intervals in London, while others, having similar objects in view, hold their meetings at the university towns, and at other centers of intelligence and industry throughout the country, giving evidence of great mental activity, and producing some of those very results which the founders of the British Association wished to see realized. If we consider further the extraordinary development of scientific journalism which has taken place, it can not surprise us when we meet with expressions of opinion to the effect that the British Association has fulfilled its mission, and should now yield its place to those special societies it has served to call into existence. On the other hand, it may be urged that the brilliant success of last year's anniversary meeting, enhanced by the comprehensive address delivered on that occasion by my distinguished predecessor in office, Sir John Lubbock, has proved, at least, that the British Association is not dead in the affections of its members, and it behooves us at this, the first ordinary gathering in the second half-century, to consider what are the strong points to rely upon for the continuance of a career of success and usefulness.

If the facilities brought home to our doors of acquiring scientific information have increased, the necessities for scientific inquiry have increased in a greater ratio. The time was when science was cultivated only by the few, who looked upon its application to the arts and manufactures as almost beneath their consideration; this they were content to leave in the hands of others, who, with only commercial aims in view, did not aspire to further the objects of science for its own sake, but thought only of benefiting by its teachings. Progress could not be rapid under this condition of things, because the man of pure science rarely pursued his inquiry beyond the mere enunciation of a physical or chemical principle, while the simple practitioner was at a loss how to harmonize the new knowledge with the stock of information which formed his mental capital in trade.

The advancement of the last fifty years has, I venture to submit, rendered theory and practice so interdependent, that an intimate union between them is a matter of absolute necessity for our future progress. Take, for instance, the art of dyeing, and we find that the discovery of new coloring matters derived from waste products, such as coal-tar, completely changes its practice, and renders an intimate knowledge of the science of chemistry a matter of absolute necessity to the practitioner. In telegraphy and in the new arts of applying electricity to lighting, to the transmission of power, and to metallurgical operations, problems arise at every turn, requiring for their solution not only an intimate acquaintance with, but a positive advance upon, electrical science, as established by purely theoretical research in the laboratory. In general engineering, the mere practical art of constructing a machine so designed and proportioned as to produce mechanically the desired effect would suffice no longer. Our increased knowledge of the nature of the mutual relations between the different forms of energy makes us see clearly what are the theoretical limits of effect; these, although beyond our absolute reach, may be looked upon as the asymptotes to be approached indefinitely by the hyperbolic course of practical progress, of which we should never lose sight. Cases arise, moreover, where the introduction of new materials of construction, or the call for new effects, renders former rules wholly insufficient. In all these cases practical knowledge has to go hand in hand with advanced science in order to accomplish the desired end.

Far be it from me to think lightly of the ardent students of nature, who, in their devotion to research, do not allow their minds to travel into the regions of utilitarianism and of self-interest. These, the high-priests of science, command our utmost admiration; but it is not to them that we can look for our current progress in practical science, much less can we look for it to the "rule-of-thumb" practitioner, who is guided by what comes nearer to instinct than to reason. It is to the man of science, who also gives attention to practical questions, and to the practitioner, who devotes part of his time to the prosecution of strictly scientific investigations, that we owe the rapid progress of the present day, both merging more and more into one class, that of pioneers in the domain of Nature. It is such men that Archimedes must have desired when he refused to teach his disciples the art of constructing his powerful ballistic engines, exhorting them to give their attention to the principles involved in their construction, and that Telford, the founder of the Institution of Civil Engineers, must have had in his mind's eye when he defined civil engineering as "the art of directing the great sources of power in nature."

These considerations may serve to show that although we see the men of both abstract and applied science group themselves in minor bodies for the better prosecution of special objects, the points of contact between the different branches of knowledge are ever multiplying, all tending to form part of a mighty tree—the tree of modern science—under whose ample shadow its cultivators will find it both profitable and pleasant to meet, at least once a year; and, considering that this tree is not the growth of one country only, but spreads both its roots and branches far and wide, it appears desirable that at these yearly gatherings other nations should be more fully represented than has hitherto been the case. The subjects discussed at our meetings are, without exception, of general interest; but many of them bear an international character, such as the systematic collection of magnetic, astronomical, meteorological, and geodetical observations, the formation of a universal code for signaling at sea, and for distinguishing lighthouses, and especially the settlement of scientific nomenclatures and units of measurement, regarding all of which an international accord is a matter of the utmost practical importance.

As regards the measures of length and weight it is to be regretted that this country still stands aloof from the movement initiated in France toward the close of the last century; but, considering that in scientific work metrical measure is now almost universally adopted, and that its use has been already legalized in this country, I venture to hope that its universal adoption for commercial purposes will soon follow as a matter of course. The practical advantages of such a measure to the trade of this country would, I am convinced, be very great, for English goods, such as machinery or metal rolled to current sections, are now almost excluded from the Continental market, owing to the unit measure employed in their production. The principal impediment to the adoption of the metre consists in the strange anomaly that although it is legal to use that measure in commerce, and although a copy of the standard metre is kept in the Standards Department of the Board of Trade, it is impossible to procure legalized rods representing it, and to use a non-legalized copy of a standard in commerce is deemed fraudulent. Would it not be desirable that the British Association should endeavor to bring about the use in this country of the metre and kilogramme, and, as a preliminary step, petition the Government to be represented on the International Metrical Commission, whose admirable establishment at Sèvres possesses, independently of its practical work, considerable scientific interest, as a well-found laboratory for developing methods of precise measurement?

Next in importance to accurate measures of length, weight, and time, stand, for the purposes of modern science, those of electricity.

The remarkably clear lines separating conductors from non-conductors of electricity, and magnetic from non-magnetic substances, enable us to measure electrical quantities and effects with almost mathematical precision; and, although the ultimate nature of this, the youngest scientifically investigated form of energy, is yet wrapped in mystery, its laws are the most clearly established, and its measuring instruments (galvanometers, electrometers, and magnetometers), are among the most accurate in physical science. Nor could any branch of science or industry be named in which electrical phenomena do not occur, to exercise their direct and important influence.

If, then, electricity stands foremost among the exact sciences, it follows that its unit measures should be determined with the utmost accuracy. Yet, twenty years ago, very little advance had been made toward the adoption of a rational system. Ohm had, it is true, given us the fixed relations existing between electromotive force, resistance, and quantity of current; Joule had established the dynamical equivalent of heat and electricity; and Gauss and Weber had proposed their elaborate system of absolute magnetic measurement. But these invaluable researches appeared only as isolated efforts, when, in 1862, the Electric Unit Committee was appointed by the British Association, at the instance of Sir William Thomson, and it is to the long-continued activity of this committee that the world is indebted for a consistent and practical system of measurement, which, after being modified in details, received universal sanction last year by the International Electrical Congress assembled at Paris.

At this congress, which was attended officially by the leading physicists of all civilized countries, the attempt was successfully made to bring about a union between the statical system of measurement that had been followed in Germany and some other countries and the magnetic or dynamical system developed by the British Association, also between the geometrical measure of resistance, the (Werner) Siemens unit, that had been generally adopted abroad, and the British Association unit, intended as a multiple of Weber's absolute unit, though not entirely fulfilling that condition. The congress, while adopting the absolute system of the British Association, referred the final determination of the unit measure of resistance to an international committee, to be appointed by the representatives of the several governments ; they decided to retain the mercury standard for reproduction and comparison, by which means the advantages of both systems are happily combined, and much valuable labor is utilized ; only, instead of expressing electrical quantities directly in absolute measure, the congress has embodied a consistent system, based on the Ohm, in which the units are of a value convenient for practical measurements. In this, which we must hereafter know as the "practical system," as distinguished from the "absolute system," the units are named after leading physicists, the Ohm, Ampère, Volt, Coulomb, and Farad.

I would venture to suggest that two further units might, with advantage, be added to the system decided on by the International Congress at Paris. The first of these is the unit of magnetic quantity or pole. It is of much importance, and few will regard otherwise than with satisfaction the suggestion of Clausius that the unit should be called a "Weber," thus retaining a name most closely connected with electrical measurements, and only omitted by the congress in order to avoid the risk of confusion in the magnitude of the unit current with which his name had been formerly associated.

The other unit I should suggest adding to the list is that of power. The power conveyed by a current of an Ampère through the difference of potential of a Volt is the unit consistent with the practical system. It might be appropriately called a Watt, in honor of that master-mind in mechanical science, James Watt. He it was who first had a clear physical conception of power, and gave a rational method of measuring it. A Watt, then, expresses the rate of an Ampère multiplied by a Volt, while a horse-power is 746 Watts, and a Cheval de Vapeur 735.

The system of electro-magnetic units would then be :

1.	Weber,	the unit of	magnetic	quantity	$= 10^8$	C. G. S. units.
2.	Ohm,	"	"	resistance	$= 10^9$	"
3.	Volt,	"	"	electromotive force	$= 10^8$	"
4.	Ampère,	"	"	current	$= 10^{-1}$	"
5.	Coulomb,	"	"	quantity	$= 10^{-1}$	"
6.	Watt,	"	"	power	$= 10^7$	"
7.	Farad,	"	"	capacity	$= 10^{-9}$	"

Before the list can be looked upon as complete two other units may have to be added, the one expressing that of magnetic field, and the other of heat in terms of the electro-magnetic system. Sir William Thomson suggested the former at the Paris congress, and pointed out that it would be proper to attach to it the name of Gauss, who first theoretically and practically reduced observations of terrestrial magnetism to absolute measure. A Gauss will, then, be defined as the intensity of field produced by a Weber at a distance of one centimetre; and the Weber will be the absolute C. G. S. unit strength of magnetic pole. Thus the mutual force between two ideal point-poles, each of one Weber strength held at unit distance asunder, will be one dyne; that is to say, the force which, acting for a second of time on a gramme of matter, generates a velocity of one centimetre per second.

The unit of heat has hitherto been taken variously as the heat required to raise a pound of water at the freezing-point through 1° Fahr. or Cent., or, again, the heat necessary to raise a kilogramme of water 1° Cent. The inconvenience of a unit so entirely arbitrary is sufficiently apparent to justify the introduction of one based on the electro-magnetic system, viz., the heat generated in one second by the current of an Ampère flowing through the resistance of an Ohm. In absolute measure its value is 10^7 C. G. S. units, and, assuming Joule's equivalent as 42,000,000, it is the heat necessary to raise 0·238 gramme of water 1° Cent., or, approximately, the $\frac{1}{1000}$ part of the arbitrary unit of a pound of water raised 1° Fahr., and the $\frac{1}{4000}$ of the kilogramme of water raised 1° Cent. Such a heat unit, if found acceptable, might with great propriety, I think, be called the Joule, after the man who has done so much to develop the dynamical theory of heat.

Professor Clausius urges the advantages of the statical system of measurement for simplicity, and shows that the numerical values of the two systems can readily be compared by the introduction of a factor which he proposes to call the critical velocity; this Weber has already shown to be nearly the same as the velocity of light. It is not immediately evident how, by the introduction of a simple multiple, signifying a velocity, the statical can be changed into dynamical values, and I am indebted to my friend Sir William Thomson for an illustration which struck me as remarkably happy and convincing. Imagine a ball of conducting matter so constituted that it can at pleasure be caused to shrink. Now let it first be electrified and left insulated with any quantity of electricity on it. After that, let it be connected with the earth by an excessively fine wire or a not perfectly dry silk fiber; and let it shrink just so rapidly as to keep its potential constant, till the whole charge is carried off. The velocity with which its surface approaches its center is the electrostatic measure of the conducting power of the fiber. Thus we see how "conducting power" is, in electrostatic theory, properly measured in terms of a velocity. Weber has shown how, in electromagnetic theory, the resistance, or the reciprocal of the conducting power of a conductor, is properly measured by a velocity. The critical velocity, which measures the conducting power in electrostatic reckoning and the resistance in electromagnetic, of one and the same conductor, measures the number of electrostatic units in the electromagnetic unit of electric quantity.

Without waiting for the assembling of the International Committee, charged with the final determination of the Ohm, one of its most distinguished members, Lord Rayleigh, has, with his collaborateure, Mrs. Sidgwick, continued his important investigation in this direction at the Cavendish Laboratory, and has lately placed before the Royal Society a result which will probably not be surpassed in accuracy. His redetermination brings him into close accord with Dr. Werner Siemens, their two values of the mercury unit being 0·95418 and 0·9536 of the B. A. unit respectively, or 1 mercury unit $= 0{\cdot}9413 \times 10^9$ C. G. S. units.

Shortly after the publication of Lord Rayleigh's recent results, Messrs. Glazebrook, Dodds, and Sargant, of Cambridge, communicated to the Royal Society two determinations of the Ohm, by different methods; and it is satisfactory to find that their final values differ only in the fourth decimal, the figures being, according to

$$\text{Lord Rayleigh} \ldots\ldots\ldots 1\ \text{Ohm} = 0{\cdot}98651\ \frac{\text{Earth Quadrant}}{\text{Second}}$$

$$\text{Messrs. Glazebrook, etc.} \quad = 0{\cdot}986439 \quad \text{"}$$

Professor E. Wiedemann, of Leipsic, has lately called attention to the importance of having the Ohm determined in the most accurate manner possible, and enumerates four distinct methods, all of which should unquestionably be tried with a view of obtaining concordant results, because upon its accuracy will depend the whole future system of measurement of energy of whatever form.

The word "energy" was first used by Young in a scientific sense, and represents a conception of recent date, being the outcome of the labors of Carnot, Mayer, Joule, Grove, Clausius, Clerk-Maxwell, Thomson, Stokes, Helmholtz, Macquorn-Rankine, and other laborers, who have accomplished for the science regarding the forces in nature what we owe to Lavoisier, Dalton, Berzelius, Liebig, and others, as regards chemistry. In this short word "energy" we find all the efforts in nature, including electricity, heat, light, chemical action, and dynamics, equally represented, forming, to use Dr. Tyndall's apt expression, so many "modes of motion." It will readily be conceived that, when we have established a fixed numerical relation between these different modes of motion, we know beforehand what is the utmost result we can possibly attain in converting one form of energy into another, and to what extent our apparatus for effecting the conversion falls short of realizing it. The difference between ultimate theoretical effect and that actually obtained is commonly called loss, but, considering that energy is indestructible, represents really secondary effect which we obtain without desiring it. Thus friction in the working parts of a machine represents a loss of mechanical effect, but is a gain of heat, and in like manner the loss sustained in transferring electrical energy from one point to another is accounted for by heat generated in the conductor. It sometimes suits our purpose to augment the transformation of electrical into heat energy at certain points of the circuit when the heat-rays become visible, and we have the incandescent electric light. In effecting a complete severance of the conductor for a short distance, after the current has been established, a very great local resistance is occasioned, giving rise to the electric arc, the highest development of heat ever attained. Vibration is another form of lost energy in mechanism, but who would call it a loss if it proceeded from the violin of a Joachim or a Norman-Neruda?

Electricity is the form of energy best suited for transmitting an effect from one place to another; the electric current passes through certain substances—the metals—with a velocity limited only by the retarding influence caused by electric charge of the surrounding dielectric, but approaching probably under favorable conditions that of radiant heat and light, or 300,000 kilometres per second; it refuses, however, to pass through oxidized substances, glass, gums, or through gases except when in a highly rarefied condition. It is easy, therefore, to confine the electric current within bounds, and to direct it through narrow channels of extraordinary length. The conducting wire of an Atlantic cable is such a narrow channel: it consists of a copper wire, or strand of wires, five mm. in diameter, by nearly 5,000 kilometres in length, confined electrically by a coating of gutta-percha about four mm. in thickness. The electricity from a small galvanic battery passing into this channel prefers the long journey to America in the good conductor, and back through the earth, to the shorter journey across the four mm. in thickness of insulating material. By an improved arrangement the alternating currents employed to work long submarine cables do not actually complete the circuit, but are merged in a condenser at the receiving station after having produced their extremely slight but certain effect upon the receiving instrument, the beautiful siphon recorder of Sir William Thomson. So perfect is the channel and so precise the action of both the transmitting and receiving instruments employed, that two systems of electric signals may be passed simultaneously through the same cable in opposite directions, producing independent records at either end. By the application of this duplex mode of working to the direct United States cable under the superintendence of Dr. Muirhead, its transmitting power was increased from twenty-five to sixty words a minute, being equivalent to about twelve currents or primary impulses per second. In transmitting these impulse-currents simultaneously from both ends of the line, it must not be imagined, however, that they pass each other in the manner of liquid waves belonging to separate systems; such a supposition would involve momentum in the electric flow, and although the effect produced is analogous to such an action, it rests upon totally different grounds—namely, that of a local circuit at each terminus being called into action automatically whenever two similar currents are passed into the line simultaneously from both ends. In extending this principle of action, quadruplex telegraphy has been rendered possible, although not yet for long submarine lines.

The minute currents here employed are far surpassed as regards delicacy and frequency by those revealed to us by that marvel of the present day, the telephone. The electric currents caused by the vibrations of a diaphragm acted upon by the human voice naturally vary in frequency and intensity according to the number and degree of those vibrations, and each motor-current, in exciting the electro-magnet forming part of the receiving instrument, deflects the iron diaphragm occupying the position of an armature to a greater or smaller extent according to its strength. Savart found that the fundamental *la* springs from four hundred and forty complete vibrations in a second, but what must be the frequency and modulations of the motor-current and of magnetic variations necessary to convey to the ear, through the medium of a vibrating armature, such a complex of human voices and of musical instruments as constitutes an opera performance! And yet such performances could be distinctly heard and even enjoyed as an artistic treat by applying to the ears a pair of the double telephonic receivers at the Paris Electrical Exhibition, when connected with a pair of transmitting instruments in front of the foot-lights of the Grand Opera. In connection with the telephone, and with its equally remarkable adjunct the microphone, the names of Riess, Graham Bell, Edison, and Hughes will ever be remembered.

Considering the extreme delicacy of the currents working a telephone, it is obvious that those caused by induction from neighboring telegraphic line wires would seriously interfere with the former, and mar the speech or other sounds produced through their action. To avoid such interference the telephone-wires if suspended in the air require to be placed at some distance from telegraphic line wires, and to be supported by separate posts. Another way of neutralizing interference consists in twisting two separately insulated telephone-wires together, so as to form a strand, and in using the two conductors as a metallic circuit to the exclusion of the earth; the working current will, in that case, receive equal and opposite inductive influences, and will, therefore, remain unaffected by them. On the other hand, two insulated wires instead of one are required for working one set of instruments, and a serious increase in the cost of installation is thus caused. To avoid this, Mr. Jacob has lately suggested a plan of combining pairs of such metallic circuits again into separate working pairs, and these again with other working pairs, whereby the total number of telephones capable of being worked without interference is made to equal the total number of single wires employed. The working of telephones and telegraphs in metallic circuit has the further advantage that mutual volta induction between the outgoing and returning cirrents favors the transit, and neutralizes, on the other hand, the retarding influence caused by charge in under-ground or submarine conductors. These conditions are particularly favorable to under-ground line wires, which possess other important advantages over the still prevailing over-ground system, in that they are unaffected by atmospheric electricity, or by snow-storms and heavy gales, which at not very rare intervals of time put us back to pre-telegraphic days, when the letter-carrier was our swiftest messenger.

The under-ground system of telegraphs, first introduced into Germany by Werner Siemens in the years 1847–'48, had to yield for a time to the over-ground system owing to technical difficulties, but it has been again resorted to within the last four years, and multiple land cables of solid construction now connect all the important towns of that country. The first cost of such a system is no doubt considerable (being about £38 per kilometre of conductor as against £8 10*s.* the cost of land lines); but, as the under-ground wires are exempt from frequent repairs and renewals, and as they insure continuity of service, they are decidedly the cheaper and better in the end. The experience afforded by the early introduction of the under-ground system in Germany was not, however, without its beneficial results, as it brought to light the phenomena of lateral induction, and of faults in the insulating coating, matters which had to be understood before submarine telegraphy could be attempted with any reasonable prospect of success.

Regarding the transmission of power to a distance, the electric current has now entered the lists in competition with compressed air, the hydraulic accumulator, and the quick-running rope as used at Schaffhausen to utilize the power of the Rhine-fall. The transformation of electrical into mechanical energy can be accomplished with no further loss than is due to such incidental causes as friction and the heating of wires; these in a properly designed dynamo-electric machine do not exceed 10 per cent, as shown by Dr. John Hopkinson, and, judging from recent experiments of my own, a still nearer approach to ultimate perfection is attainable. Adhering, however, to Dr. Hopkinson's determination for safety's sake, and assuming the same percentage in reconverting the current into mechanical effect, a total loss of 19 per cent results. To this loss must be added that through electrical resistance in the connecting line wires, which depends upon their length and conductivity, and that due to heating by friction of the working parts of the machine. Taking these as being equal to the internal losses incurred in the double process of conversion, there remains a useful effect of $100 - 38 = 62$ per cent, attainable at a distance, which agrees with experimental results, although in actual practice it would not be safe at present to expect more than 50 per cent of ultimate useful effect, to allow for all mechanical losses.

In using compressed air or water for the transmission of power, the loss can not be taken at less than 50 per cent, and as it depends upon fluid resistance it increases with distance more rapidly than in the case of electricity. Taking the loss of effect in all cases as 50 per cent, electric transmission presents the advantage that an insulated wire does the work of a pipe capable of withstanding high internal pressure, which latter must be more costly to put down and to maintain. A second metallic conductor is required, however, to complete the electrical circuit, as the conducting power of the earth alone is found unreliable for passing quantity currents, owing to the effects of polarization ; but, as this second conductor need not be insulated, water or gas pipes, railway metals, or fencing-wire, may be called into requisition for the purpose. The small space occupied by the electro-motor, its high working speed, and the absence of waste products, render it specially available for the general distribution of power to cranes and light machinery of every description. A loss of effect of 50 per cent does not stand in the way of such applications, for it must be remembered that a powerful central engine of best construction produces motive-power with a consumption of two pounds of coal per horse-power per hour, whereas small engines distributed over a district would consume not less than five ; we thus see that there is an advantage in favor of electric transmission as regards fuel, independently of the saving of labor and other collateral benefits.

To agriculture, electric transmission of power seems well adapted for effecting the various operations of the farm and fields from one center. Having worked such a system myself in combination with electric lighting and horticulture for upward of two years, I can speak with confidence of its economy, and of the facility with which the work is accomplished in charge of untrained persons.

As regards the effect of the electric light upon vegetation there is little to add to what was stated in my paper read before Section A last year, and ordered to be printed with the report, except that, in experimenting upon wheat, barley, oats, and other cereals sown in the open air, there was a marked difference between the growth of the plants influenced and those uninfluenced by the electric light. This was not very apparent till toward the end of February, when, with the first appearance of mild weather, the plants, under the influence of an electric lamp of 4,000 candle-power placed about five metres above the surface, developed with extreme rapidity, so that by the end of May they stood above four feet high, with the ears in full bloom, when those not under its influence were under two feet in height, and showed no sign of the ear.

In the electric railway first constructed by Dr. Werner Siemens, at Berlin, in 1879, electric energy was transmitted to the moving carriage or train of carriages through the two rails upon which it moved, these being sufficiently insulated from each other by being placed upon well-creosoted cross-sleepers. At the Paris Electrical Exhibition, the current was conveyed through two separate conductors making sliding or rolling contact with the carriage, whereas in the electric railway now in course of construction in the north of Ireland (which when completed will have a length of twelve miles) a separate conductor will be provided by the side of the railway, and the return circuit completed through the rails themselves, which in that case need not be insulated; secondary batteries will be used to store the surplus energy created in running down-hill, to be restored in ascending steep inclines, and for passing roadways where the separate insulated conductor is not practicable. The electric railway possesses great advantages over horse or steam power for towns, in tunnels, and in all cases where natural sources of energy, such as water-falls, are available; but it would not be reasonable to suppose that it will in its present condition compete with steam propulsion upon ordinary railways. The transmission of power by means of electric conductors possesses the further advantage over other means of transmission that, provided the resistance of the rails be not very great, the power communicated to the locomotive reaches its maximum when the motion is at its minimum—that is, in commencing to work, or when encountering an exceptional resistance—whereas the utmost economy is produced in the normal condition of working when the velocity of the power-absorbing nearly equals that of the current-producing machine.

The deposition of metals from their solutions is perhaps the oldest of all useful applications of the electric current, but it is only in very recent times that the dynamo-current has been practically applied to the refining of copper and other metals, as now practiced at Birmingham and elsewhere, and upon an exceptionally large scale at Ocker, in Germany. The dynamo-machine there employed was exhibited at the Paris Electrical Exhibition by Dr. Werner Siemens, its peculiar feature being that the conductors upon the rotating armature consisted of solid bars of copper thirty mm. square, in section, which were found only just sufficient to transmit the large quantity of electricity of low tension necessary for this operation. One such machine consuming four-horse power deposits about three hundred kilogrammes of copper per twenty-four hours; the motive-power at Ocker is derived from a water-fall.

Electric energy may also be employed for heating purposes, but in this case it would obviously be impossible for it to compete in point of economy with the direct combustion of fuel for the attainment of ordinary degrees of heat. Bunsen and Sainte-Claire Deville have taught us, however, that combustion becomes extremely sluggish when a temperature of 1,800° C. has been reached, and for effects at temperatures exceeding that limit the electric furnace will probably find advantageous applications. Its specific advantage consists in being apparently unlimited in the degree of heat attainable, thus opening out a new field of investigation to the chemist and metallurgist. Tungsten has been melted in such a furnace, and eight pounds of platinum have been reduced from the cold to the liquid condition in twenty minutes.

The largest and most extensive application of electric energy at the present time is to lighting, but, considering how much has of late been said and written for and against this new illuminant, I shall here confine myself to a few general remarks. Joule has shown that, if an electric current is passed through a conductor, the whole of the energy lost by the current is converted into heat ; or, if the resistance be localized, into radiant energy comprising heat, light, and actinic rays. Neither the low heat-rays nor the ultra-violet of highest refrangibility affect the retina, and may be regarded as lost energy, the effective rays being those between the red and violet of the spectrum, which in their combination produce the effect of white light.

Regarding the proportion of luminous to non-luminous rays proceeding from an electric arc or incandescent wire, we have a most valuable investigation by Dr. Tyndall, recorded in his work on "Radiant Heat." Dr. Tyndall shows that the luminous rays from a platinum wire heated to its highest point of incandescence, which may be taken at 1,700° C., formed $\frac{1}{24}$ part of the total radiant energy emitted, and $\frac{1}{10}$ part in the case of an arc-light worked by a battery of 50 Grove's elements. In order to apply these valuable data to the case of electric lighting by means of dynamo-currents, it is necessary in the first place to determine what is the power of 50 Grove's elements of the size used by Dr. Tyndall, expressed in the practical scale of units as now established. From a few experiments lately undertaken for myself, it would appear that 50 such cells have an electromotive force of 98·5 Volts, and an internal resistance of 13·5 Ohms, giving a current of 7·3 Ampères when the cells are short-circuited. The resistance of a regulator such as Dr. Tyndall used in his experiments may be taken at 10 Ohms, the current produced in the arc would be $\frac{98 \cdot 5}{13 \cdot 5 + 10 + 1} = 4$ Ampères (allowing one Ohm for the leads), and the power consumed $10 \times 4^2 = 160$ Watts ; the light power of such an arc would be about 150 candles, and, comparing this with an arc of 3,308 candles produced by 1,162 Watts, we find that $\left(\frac{1162}{160}\right)$, i. e., 7·3 times the electric energy produce $\left(\frac{3308}{150}\right)$ i. e., 22 times the amount of light measured horizontally. If, therefore, in Dr. Tyndall's arc $\frac{1}{10}$ of the radiant energy emitted was visible as light, it follows that in a powerful arc of 3,300 candles, $\frac{1}{10} \times \frac{22 \cdot 0}{7 \cdot 3}$, or fully $\frac{1}{3}$, are luminous rays. In the case of the incandescent light (say a Swan light of twenty-candle power) we find in practice that nine times as much power has to be expended as in the case of the arc-light ; hence $\frac{1}{3} \times \frac{1}{9} = \frac{1}{27}$ part of the power is given out as luminous rays, as against $\frac{1}{24}$ in Dr. Tyndall's incandescent platinum—a result sufficiently approximate considering the wide difference of conditions under which the two are compared.

These results are not only of obvious practical value, but they seem to establish a fixed relation between current, temperature, and light produced, which may serve as a means to determine temperatures exceeding the melting-point of platinum with greater accuracy than has hitherto been possible by actinimetric methods in which the thickness of the luminous atmosphere must necessarily exercise a disturbing influence. It is probably owing to this circumstance that the temperature of the electric arc as well as that of the solar photosphere has frequently been greatly overestimated.

The principal argument in favor of the electric light is furnished by its immunity from products of combustion which not only heat the lighted apartments, but substitute carbonic acid and deleterious sulphur compounds for the oxygen upon which respiration depends; the electric light is white instead of yellow, and thus enables us to see pictures, furniture, and flowers as by daylight; it supports growing plants instead of poisoning them, and by its means we can carry on photography and many other industries at night as well as during the day. The objection frequently urged against the electric light, that it depends upon the continuous motion of steam or gas engines, which are liable to accidental stoppage, has been removed by the introduction into practical use of the secondary battery; this, although not embodying a new conception, has lately been greatly improved in power and constancy by Planté, Faure, Volckmar, Sellon, and others, and promises to accomplish for electricity what the gas-holder has done for the supply of gas and the accumulator for hydraulic transmission of power.

It can no longer be a matter of reasonable doubt, therefore, that electric lighting will take its place as a public illuminant, and that, even though its cost should be found greater than that of gas, it will be preferred for the lighting of drawing-rooms and dining-rooms, theatres and concert-rooms, museums, churches, warehouses, show-rooms, printing establishments, and factories, and also the cabins and engine-rooms of passenger-steamers. In the cheaper and more powerful form of the arc-light, it has proved itself superior to any other illuminant for spreading artificial daylight over the large areas of harbors, railway-stations, and the sites of public works. When placed within a holophote the electric lamp has already become a powerful auxiliary in effecting military operations both by sea and land.

The electric light may be worked by natural sources of power such as water-falls, the tidal wave, or the wind, and it is conceivable that these may be utilized at considerable distances by means of metallic conductors. Some five years ago I called attention to the vastness of those sources of energy, and the facility offered by electrical conduction in rendering them available for lighting and power-supply, while Sir William Thomson made this important matter the subject of his admirable address to Section A last year at York, and dealt with it in an exhaustive manner.

The advantages of the electric light and of the distribution of power by electricity have lately been recognized by the British Government, who have just passed a bill through Parliament to facilitate the establishment of electrical conductors in towns, subject to certain regulating clauses to protect the interests of the public and of local authorities. Assuming the cost of electric light to be practically the same as gas, the preference for one or other will in each application be decided upon grounds of relative convenience, but I venture to think that gas-lighting will hold its own as the poor man's friend.

[*To be continued.*]

PHYSIOGNOMIC CURIOSITIES.

By FELIX L. OSWALD, M. D.

BUT, besides these local ideals (referred to in the preceding number), there is an international standard of beauty which has survived the mutations in other canons of taste. Athenæus mentions the ingredients of a once-famous sea-fish sauce, and the attempt to try his receipt nearly suffocated the courtiers of Queen Christina with nausea and laughter. Petronius, surnamed the Arbiter of Elegance, would be kicked out by any modern publisher of obscene literature. The Greeks admired the knife-grinder music of the tree-cicada, and their own melodies would probably rout an American audience, but we all can appreciate the merits of their sculptured paragons; their Venus would bag the prize-committee of an Alaska squaw-fair, as she captured the stout knight Tannhäuser.

"Beautiful features are the credentials by which Nature introduces her representatives," says Wieland. Beauty is superior fitness, as a Darwinian would say, and in this respect, too, the pre-eminence of the ancient Greeks was probably the outcome of their general physical and mental superiority to their fellow-men, though they themselves believed in the existence of a chemical pan-cosmetic. In the trial of the arch-quack Cagliostro, it came out that, during the twelve years from 1765–'77, he had realized three million francs from the sale of his "Recipe for Beauty," a recipe which has been more eagerly searched for than the philosopher's stone, or the secret of longevity. Andreas Cisalpinus made the notable discovery that an ointment of crushed locusts and misletoe-juice would treble the charms of the fairest woman. "What must I do to become very beautiful?" the damsel in "Don Quixote" asks the enchanted Moor's head. "*Que seas muy honrada*—be very continent," replies the head. Paracelsus recommends meadow-dew, gathered in the morning while the May-moon is on the increase; and Montaigne inquires into the habits of the most well-favored tribes of every country, but confesses that the problem is rather an evasive one, the coast-dwellers of Sweden being as distinguished for their comeliness as the highlanders of Aragon, and the Normandy cider-drinkers not less than the Tuscan wine-drinkers. His only general rule, however, still holds good: that out-door dwellers are never wholly ill-favored, nor in-door workers altogether lovely; and we might say the same of alcohol-drinkers and total abstainers: the schnapps-worshiping natives of the Tyrolese highlands make amends by their active out-door life, as Lowell factory-girls by their teetotalism. There is a good deal in race, though. "*Angeli sunt; non Angli*," Pope Stephen III wrote more than a thousand years ago to Archbishop Cuthbert, who had sent him a batch of Anglo-Saxon neophytes, and a trace of the same angelic features may still be recognized among the little ragamuffins of many a Schleswig-Holstein coast-village, where men subsist on brandy, cheese, and sour rye-bread. Their neighbors, the Pomeranians, are a manful if not celestial generation, and, in spite of their dreary moorlands, very fond of out-door sports. But farther east Nature succumbs to art, and the northern Russians are about as outrageously unprepossessing as indoor-life and a combination of all vices could make the image of the Creator. Extremes meet, though, and their Emperor has the honor of commanding twelve regiments of the most godlike men of the present world—the lance-cuirassiers of the body-guard, recruited in the highlands of Lesghia and Daghestan. Nearly all the natives of the Caucasus have that fatal gift of beauty which made their land the favorite hunting-ground of the harem-agents, and this gave the Czar a pretext for treating it as a Turkish dependency. But no social degradation could counteract the combined influence of the Caucasian climate, hardy habits, temperance, and frugality, for the Circassian mountaineers are teetotalers by religion and vegetarians by preference—figs, honey, barley-cakes, and milk, being the staples of their diet. They are physically self-made men, for their language proves that their ancestors were Turanians—first-cousins of the owl-faced nomads of the Mongolian steppe.

Pernetti believes that "the study of physiognomy has been neglected since men began to neglect their good looks, to which the classic nations attached an importance which we can nowadays hardly comprehend." Since Pernetti confines his remarks to his own sex we may plead guilty to his indictment, and it is true that the ancients combined their heroics with a good deal of Beau-Brummelism. "He abuses the right of a man to be ugly," Madame de Staël said of one of her admirers, but the ancient Greeks denied that right altogether, and their intolerance in this respect seems to have surpassed anything one could mention of contemporary notions, though it may be true that the military academies of Prussia and Saxony make homeliness a bar to admission. Even Plato, in his "Republic," advises his lawgiver to oppose all habits that might tend to lower the standard of physical æsthetics;

Zopyrus berated Socrates as if he had caught a pickpocket ; nay, the Spartan Gerontes fined one of their kings for courting a thick-set lady, because "they could not permit him to afflict the state with a race of undersized princes." In the record of the battle of Platæa, a certain Callicrates is mentioned simply because he was the fairest of all the Greeks who fought on that day ; and Plutarch speaks of a slave whom Nicias set free for winning the applause of all Athens in a play (or religious festival), where he enacted the *rôle* of the Bacchus Methystes ; and even more amazing is what Strabo tells us of one Philippus, who joined in the expedition of Doricus against Erix, and who, after having been slain and stripped by the people of Segeste, was taken up and grandly buried by his foes, and long afterward *worshiped as a demigod*, on account of his great beauty.

But the *nil admirari* is not always a voluntary virtue. De Lagny, in his account of a visit to the eastern tribes of Circassia, describes the horrible sight of a battle-field in the rocky valley of Halistan, where the day before six Russian regiments had been routed by the Lesghian mountaineers. "But the victory was dearly bought," says he ; "in the bed of the river, and all along the northern shore, we found the unburied bodies of the heroes who had died in defense of their country. R—— was overcome by the sight, and asked us to hurry on, but on the outskirts of a chestnut-grove, that shades the valley of a tributary creek, he suddenly stopped, and soon we were all assembled around the body of a Lesghian warrior, who had fallen, with a bullet through his head, at the foot of a shattered tree. The man wore the green scarf of his tribe, and, from the profusion of ornaments on his belt and his neck, seemed to have been a chieftain among his companions. Yet it was not his grotesque attire, nor his form, which was that of a Hercules, which held us spellbound—it was his face, a face which in manly beauty exceeded anything Phidias or Thorwaldsen ever expressed in marble. We stood around, almost immovable, as men will before a phenomenon they may see once and no more. No one spoke a word, till Surgeon Herbert, of the Chasseurs d'Afrique, broke the silence ; baring his head—"Hats off, messieurs ; *voici l'image de Dieu*—we stand before the image of God !"

The Duke de Rohan used to say that "it had pleased Providence to put something between the eyes of a French cavalier which a plebeian could not look at without quailing." The guillotine seems to have settled that difficulty, but it is true that there is an innate majesty in some faces which commands the respect even of those who would decline to recognize any other claims to superior rank, not excepting those of an established reputation. For some reason or other —possibly the all-pervading hypocrisy of our Western civilization— this *vultus majestatis* has almost become a monopoly of the Mohammedan nations. During the revolt of the Wahabees, the commander of the sectarian army had frequent occasion to notice the efficiency of one Aboo Arish, a subaltern officer, whose stern command and intrepid bearing had often retrieved the fortune of a doubtful battle; and after the close of the war it occurred to him to utilize the stentorian talent of his lieutenant in a different way. He made him the coadjutor of his envoy to the neighboring chieftains, and had no cause to regret his appointment, for, even on occasions that would have foiled the strategy of a European diplomat, the mere presence of Aboo Arish never failed to overawe the council of a hostile tribe.

This power of a physiognomic majesty is well illustrated by another story from the Caucasus, which I find in Lermontoff's history of the eventful campaign that ended with the capture of the prophet-chieftain, Shamyl ben Haddin, on the plateau of Ghunib, September 10, 1859. Eighteen hundred against twenty-six thousand, his men had defended themselves from early morning till after noon, and, when his ammunition was exhausted, began to hurl rocks and cannon from the parapets. But toward evening the citadel was taken by storm, and the survivors of the garrison were led forth, torn and bleeding, but resolved to die game. The officers of the Russian headquarters had adjourned for supper, as soon as the bloody work was done, but, when the commanding officer was notified that the great chieftain was among the prisoners, he gave orders to conduct him at once into his presence. A noise of boisterous mirth greeted the arrival of Shamyl when his escort halted before the commander's tent, but when he stood in the presence of his captors, like Ormuz before the court of Ahriman, a deep silence came over the assembly, and the insolent Junkers of Baryatinski's staff involuntarily rose to their feet, as if they felt the presence of a superior being!

"When he contracted his eyebrows, his look could assume a penetrative force that I have never seen equaled," says Lermontoff. Marius and Robert Burns had such eyes, and also Vasco de Gama, *él de los ojos terribles*, who "could read a face like an open book," and once quelled the spokesmen of a mutinous crew by simply keeping them under the fire of that terrible gaze.

How men can be affected by excessive ugliness history illustrates by many amusing examples. We have already referred to the nose of the first Hapsburger, which came so near defeating his nomination; but, if the descriptions of Caliph Walid's face are authentic, he was lucky that his accession to the throne of the Prophet did not depend upon the votes of men with physiognomic prejudices. His nose was crooked and sharp like a reaping-hook, his cheeks so tumid that "they could be seen from behind"; his mouth was atrocious, and, to put a finishing touch to the portrait, Abulfeda informs us that he was marked by the small-pox as man was never marked before, "pits like auger-holes" distributed over his face from ear to ear.

"*Non cuique datum est habere nasum;* another Eastern potentate, Ghengis Khan, had no nose to speak of, and was otherwise so fright-fully ugly that he found it easy to pass for a superhuman or *subter*-human being. His next neighbors, the original Huns, were actually believed to derive their origin from a diabolical *liaison* of the Scythian witches; such at least was the theory of the Visigoths, who, barbarians though they were, enjoyed more than the average share of physical beauty, and were altogether overcome by the aspect of those Turanian fiends. "In many a battle," says Jornandes, "the warriors who had withstood the onset of the Roman legions were seized with a nameless terror and put to instant flight by the sight of those male Medusas."

"Hatred at first sight is no impossibility. I know that from personal experience," says Charles Lamb, "and I can believe the story of two persons meeting, who never saw one another before, and instantly fighting." Marshal Vendôme was so ugly that he avoided going near a looking-glass. But once, on entering a tent that had been furnished by proxy, he found a mirror over the wash-stand and could not resist the temptation to have a good look at himself. But, as he looked, his hand stole to his belt, and with a muttered curse and "*Quelle figure!*" he broke the glass with a pistol-shot. La Maintenon had seen him only once in her life, and ever afterward persecuted him with the rancor of a personal enemy, and used to refer to his person as "*ce cochon à deux bottes.*"

But there is also such a thing as love at first sight, and in Schopenhauer's theory of sexual selection many of its apparent caprices have been explained with ultra-Baconian ingenuity. "The ultimate object of all love-dramas," says he, "is really more important than all other human concernments whatever, and fully worthy of the deep earnest of the actors. For what they decide is nothing less than the *composition* of the next generation. The apparently frivolous whims of Amor determine the physical and moral peculiarities of the *dramatis personæ* who shall mount the stage after we are gone. The sexual instinct, *per se*, only guarantees the perpetuity of the species; our erotic caprices determine the qualities of its representatives. . . . In regard to the human species the importance of this perpetual selection is enhanced by the perpetual necessity of counteracting the influence of degenerative agencies. Nature continually strives to correct all deviations from the standard of her normal types, and thus assists the survival of the fittest by preventing the birth of the most unfit. The metaphysical *rationale* of passionate love is, therefore, the instinctive perception of an opportunity to counteract individual abnormities, to neutralize them in a being of the next generation. Unless circumstances limit the scope of selection, every one chooses his or her *physiological complement.* A small man prefers a large woman, and *vice versa;* the manliest man the most feminine female, while weaklings are apt to admire a strong-minded woman. Pale blondes dote on a dark complexion, blonde and whitish hair being, properly speaking, an abnormity, analogous to the albinism of certain rodents, or at least to the recognized staminal inferiority of a white horse. . . . A child inherits its character from the father, its intellect from the mother. Firmness of will and courage, as well as the innate kindness and uprightness of a man, are therefore more potent elements of popularity with the other sex than intellectual brilliancy. Mental obtuseness does not impair the chances of an otherwise eligible suitor; on the contrary, genius (as an abnormity) may exercise an unfavorable effect. Hence the apparent paradox of a gross and stupid fellow superseding a refined and sensible man in the affection even of sentimental ladies; and the frequency of glaringly heterogeneous matches: he, practical, egotistical, and prosaic; she, all moonshine and poetry; he, metaphysical and learned; she, a goose. . . . Men, on the other hand, are guided less by the character qualities of a girl than by her intellectual attainments, though secondary to the importance of physical qualifications. In accordance with the perception of this bias, mothers try to enhance the attractions of their daughters by educational devices, music, painting, foreign languages, etc. Even a native sprightliness of the female mind is apt to outweigh the rarer merits of the heart, whence so many Socrateses have found their Xantippes—e. g., Shakespeare, Albrecht Dürer, Goethe, Byron, and others. Female beauty, though, will eclipse both goodness and wit, while, in the rivalry of the males, strength in all its forms is on the whole the main condition of success; in the eyes of the normal woman even the extreme of turpitude (moral or physical) being more pardonable than weakness."

When Bishop Lee sat down on his coffin and heard the sheriff's command of "Ready!" followed by the click of six Springfield rifles, the attendant photographer requested him to assume a pleasing expression of countenance." There have been individuals who possessed the requisite control over their facial muscles, though they might have lacked the inclination to gratify the enterprising artist. "A prince of the Church should know how to die with dignity," said Cardinal Frascati when he had been treated to a dose of poison and felt his senses give way. In spite of all entreaties he persisted in dying seated upright, with his hands folded and his face turned upward in an attitude of meditation. Savonarola kept up a controversy at the very stake, and, while the flames scorched his knees, his eyes twinkled, as he watched the effect of a caustic repartee.

When the French garrison of Detroit made a sally against the besieging Indians, Bœuf-courant, an Ojibway chieftain, had both his legs torn away by a cannon-ball. Carried into the fort, he refused medical attendance, and his young son, who had never left his side, at his bidding raked a pile of cold ashes from the guard-room chimney, and on this pile deposited his crippled father, with the stumps downward. Thus enabled to sit upright, he calmly smoked his pipe, till the commander of the fort suggested his removal to a prison-cell. They gave him a quarter of an hour to finish his smoke, and he sat motionless as a statue; but, when one of the soldiers went to remind him that his time was up, they found that the fifteen minutes and the old chief had expired together. James Nisbet, in his "Annals of California," relates that in the fall of 1851, when Lynch-justice was the only law of the Territory, a multitude of citizens assembled on the Plaza of San Francisco, to hang a notorious rascal, who had amassed money by burglary, but was at last caught *in flagrante*. Mr. Nisbet made his way through the crowd, and seeing a gentleman standing a little apart, calmly smoking a cigarette, he went up to him and inquired if he could tell him who it was they were going to hang. The man thus addressed removed the ashes from his cigarette, and with great politeness replied, "Unless I'm quite mistaken, it's me, sir," and then resumed his smoke. "Ten minutes after," says Mr. Nisbet, "the same gentleman was dangling by his neck from a balcony of the Pacific Hotel."

During the first war of the Carlists and Cristinos an attempt was made to assassinate the Count de Santa Cruz, who commanded the city of Barcelona, by blowing up an old stone chapel where he used to transact his official business. A desperado undertook the job, and, after planting his powder and lighting the match, he went to the count's hotel, engaged him in conversation, and under pretext of some official business started him toward the loaded chapel. Once there, he calculated, the count would stay an hour or so, and he could slip out before the explosion. But, just as they entered the inclosure of the chapel, the building went up with an earth-shaking crash, and the would-be assassin, though unhurt, stood trembling and pale as death. Santa Cruz readjusted his hat, which had been knocked sideways by a flying fragment, and, turning to his companion, very quietly observed: "You always ought to wet a slow match in such hot weather, *compañero;* otherwise they burn double-quick, and the thing goes off prematurely."

It is to men of this class that Lavater refers, when he speaks of individuals who have such a control over their features that *they prevent even violent passions* from impressing them with the marks they would leave on other faces. As to the question what vices can be detected by the expression of the countenance, opinions differ very widely. Physical excesses *always* leave their mark, and there is no doubt that an expert physician can recognize a drunkard, a debauchee, a glutton, or an opium-eater without any difficulty, and even without confounding the effects of their different vices. But, though phrenologists assert, and every lover of justice should wish, it to be otherwise, overwhelming evidence obliges one to admit that, as a rule, moral turpitude leaves no such traces. If free from health-destroying habits, a plotting fiend may disarm suspicion with the ideal forms and soft eyes of Guido's dream-children, and the records of history not less than those of every-day life abound with instances of such masked scoundrels.

Every large penitentiary in Anglo-Saxondom has inmates who might *pose* for any saint in the Roman almanac, while an honest village-priest of Southern Bavaria may combine in his face the deformities of Breughel's seven devils by indulging in salted pork, lager-bier, and sauerkraut. Some years ago I passed a few days at Brownsville, Texas, during the session of the United States District Court. The *cause célèbre* of the season was the case of Francisco Hernandez, a Mexican bandit, who had infested the Rio Grande frontier for more than three years before he was caught in his favorite trick of robbing the poor farm-houses of his countrymen, whenever the absence of the able-bodied males gave him a chance of executing his designs with a minimum risk to his own skin. Though he assured the court that he had no hard feelings against any of his victims, he had been obliged, in the line of his business, to kill eight different persons—all females and minors. His last enterprise had involved a hand-to-hand fight with a stout old woman, who broke his left arm before he dispatched her. He was tracked to the Rio Grande, and, trying to swim the river in his crippled condition, saw himself obliged to turn back into pistol-range of his pursuers, was captured, and arraigned for five murders in the second and three in the first degree. I strolled into the court-house while his trial was going on, expecting to see one of those bull-necked old cut-throats of the negroid type, who abound in this region of murder and mixed races. He proved to be a pale-faced creole, of some eighteen or twenty years, slender-built, modest-spoken, and resigned-looking to a pathetic degree. His profile was absolutely perfect, and the same might have been said of his eyes, if their look had not been too ghost-like spiritual to leave an agreeable impression. Cæsar Borgia, the natural son of Pope Alexander VI, was at once the wickedest and handsomest man of his time. The fiend who aggravated the guilt of the most unheard-of crimes by perpetrating them in the name of a sentimental religion wore a face which, in the words of Della Porta, might inspire a saint to live up to every sublime precept of that creed. The mere sound of his voice succeeded where the arguments of others failed; his eye could beam with the inspiration of a prophet while he meditated those *fatti assassini* to which the records of the most barbarous nations furnish scarcely a parallel. It is a pity that his skull has not been preserved, though we need not doubt that it did exhibit all those fine "developments" that were necessary to harmonize with such a face.

Cæsar Borgia had hostile biographers, who may have exaggerated his faults, and artist-friends who, perhaps, flattered him in portraits; but the same can not be said of Mohammed II, the conqueror of Constantinople, whose crimes were palliated by his abject courtiers, and to whose majestic beauty his enemies bear witness. The historian Phranza, who lost his fortune and his country in the downfall of the Byzantine Empire, and whose only son was stabbed by the hand of the Sultan, describes him as the physical ideal of a perfect man. A potentate of leonine bearing, with a beard that surrounded his face like a mane, and a pair of wonderful Oriental eyes, combined with features of classic regularity, he appeared "every inch a king," and the embassadors who visited his court from all parts of the world agreed that he was the manliest-looking man they had ever seen. Yet this same paragon was an infidel alike to his faith and his friends, inhumanly cruel, and mean to the rare degree of being at once avaricious and overbearing. But, though his subjects groaned under his yoke, no murmur ever reached his ears, and his presence inspired the genuine reverence due to a superior being. He was uxorious and a tool in the hands of his favorites, but his superintendence always insured the success of a campaign; he had that gift of commanding that can dispense with personal courage by inspiring it in others. Absalom, Cambyses, the younger Dionysius, Caligula, Louis le Débonnaire, Churchill, King Christian of Denmark, Ali Pasha, and Benedict Arnold, are well-known confirmations of a truth which, as Goethe observes, the experience of every man, but nobody's instinct, teaches him—that beauty and goodness are not identical. Children and child-like men, and most men *a priori*, are prepossessed by a handsome face and repulsed by an ugly one, and one can understand Madame de Staël when she speaks of unpardonable faces. Ugliness *is* something abnormal, and originally, no doubt, the consequence of sin—though, perhaps, quite unconscious sin—against the physical laws of God.

But, even about moral aberrations, the language of the face is not altogether silent, though it announces them in a different way. Besides those of the studied, calm expression, there are indications in what Sir Charles Bell calls the *habits of the face*, the manner of laughing, of speaking under the influence of passion, or of meeting a sudden glance. In these *habits* even moral peculiarities may betray themselves to a shrewd observer, and often quite unbeknown to the object of observation. Experience, in fact, can teach us to distinguish acquired from hereditary beauty or ugliness. They may be combined in the same face, but are altogether independent of each other, and differ as forms from manners, or talents from culture. The tongue, though, can be taught to refute this language of the features—hence the significance of first impressions.

Physiognomy and craniology are yet far from having been reduced to the rules of a logical system—"the one through want of cultivation, the other in spite of it," as the physiologist Camper said of his and Pastor Goetze's science. In the mean time we all practice physiognomy instinctively, though by methods which it would not be quite easy to define. What subtile differences in the form of the features enable us to indicate the age of a man, his habits, his temper, the average amount of his education, and even the country of his birth!

The traveler Kohl mentions a landlord in Kent Square, Liverpool, who combined his restaurant with an emigrant boarding-house, and won many wagers by his almost infallible faculty for recognizing the nationality of his boarders: without asking them to speak, without taking any cognizance of the peculiarities of their dress, he scrutinized their features, and promptly announced the result of his observation.

Dr. Gellmayer, a druggist of Troppau, in Austrian Silesia, had for years the casting vote on every lunacy commission of his native province. He distinguished between chronic and transient ("emotional") insanity, and recognized the former exclusively by physiognomic symptoms. "I could approximately describe that expression," says he, "by comparing it to the peculiar look of a person who has forgotten something, and is trying in vain to recollect it. In the large subdivision of misanthropic lunatics that look is combined with a certain peevish furtiveness of the eye." When his colleagues wished to release a doubtful patient, Dr. Gellmayer sometimes withheld his opinion, but his averse decisions proved always correct.

Could Spurzheim have deduced such verdicts from craniological indications?

THE BRITISH LION.

By W. BOYD DAWKINS.

THE British Lion to be dealt with in the following pages is not that of the heralds, nor is it the amiable, shy, rather tame animal just now crouching down behind "the silver streak," pretending to fear lest the foreigner should get at him unawares through a tunnel, nor yet is it the ephemeral much-to-be-pitied creature of the drawing-room. It is a lion, indeed, the king of beasts, the story of whose coming into Britain is a part of the greater story of his sojourn in Europe, that can not be told properly without discussing the ancient geography and climate, or without dealing with some vexed points in historical criticism. It is a story which begins in the remote geological past, revealed by pickaxe and shovel, and ends, well within the frontier of history, in the works of ancient Greek writers.

The first view which we get of the lion in Britain in the geological record is in the valley of the lower Thames, at Grays Thurrock and Ilford in Essex, and at Crayford and Erith in Kent. The strata in those places consist of loams, sands, and gravels swept down by the Thames when it flowed at a height of at least seventy feet above its present level, and swung in a series of bold curves from side to side in the broad valley in which London stands, with a swifter current than at the present time. They are all of the same general character, and the brick-field at Crayford presents us with a most convenient stand-point for surveying the conditions of life in Southern Britain while they were being accumulated. The visitor in Stoneham's Pit at that place sees a brick-pit several hundred yards in extent, composed of sand, shingle, and mud-banks, containing land and fresh-water shells and numerous fossil bones resting where they happen to have been dropped by the current, and these strata he can follow until they abut on the chalk forming the ancient side of the river. The land-shells have evidently been swept down by the ancient Thames from its higher reaches, and the fresh-water species have for the most part lived where they are now found, in the old river-bottom. These last are now living in our streams and lakes, with the three following exceptions. A small bivalve (*Cyrena fluminalis*), there very abundant, has long ago forsaken the rivers of Europe. It still, however, lives in the Nile and in the streams of Cashmere, and probably also in the rivers and fresh-water lakes of Siberia, and is also used as food by the poorer people inhabiting the banks of the rivers of the great plain of China. A fresh-water mussel (the *Unio littoralis*) still thrives in the rivers of France, in the Seine and Loire ; and a tiny fresh-water snail (*Paludina marginata*) abounds in the streams of Southern France. Thus in the ancient Thames at this time fresh-water mollusca now living in Britain were to be found side by side with species now to be sought in the rivers of France or of Asia. The fossil remains of the mammalia scattered through the brick-earths as they were dropped by the current have been discovered in astonishing numbers, and most of them consist of isolated fragments, such, for example, as a broken skull of the musk-sheep. Huge tusks of elephants lie side by side with antlers of stags and skulls and bones of bisons and horses. Sometimes entire limbs have been preserved with bones in place, and in one case the entire skeletons of a family of marmots surprised in the attitude of hibernation, with paws over their noses, young and old together, stand out from a block of hardened loam. Such as these are the materials for working into a picture the conditions of life in the valley of the Thames while these fluviatile deposits were being formed.

The district was then haunted by many extinct wild animals, and by living species no longer found together in any part of the world. Stags and roe-deer lived in the forest side by side with the gigantic and extinct Irish elk, the woolly rhinoceros, and the straight-tusked elephant. Three kinds of rhinoceros, one of them covered with wool and hair, fed on the branches and the undergrowth ; wild-boars plowed up the ground in search of food, and the glades afforded pasture to innumerable horses, bisons, and large horned uri ; and, when forest and glade were alike covered with a snowy mantle, a few musk-sheep, now the most arctic of all the herbivores, were to be seen on the banks of the Thames in Kent. Among the smaller animals we may note the pouched marmot and the water-rat. These animals were kept in check by numerous beasts of prey ; the smaller of them by stealthy foxes and wild-cats, and the larger by grizzly and brown bears and packs of wolves. The stillness of night was from time to time broken by the weird laughter of the spotted hyena and by the roar that proclaimed the presence of the king of beasts. Otters pursued their finny prey in the Thames at Grays Thurrock, and at Ilford beavers were to be seen disporting themselves round their wonderful habitations, and vanishing beneath the surface as if by magic at the splash caused by the bulky form of the hippopotamus as he plunged into the water.

Nor are we without a clew as to the vegetation then covering the district, since the present flora of this country arrived here at a geological period long before the time under discussion. We may therefore complete our ideal by picturing to ourselves oaks, ashes, and yews among the important trees in the forest, while the thickets that sheltered such a strange assemblage of animals did not differ in any important particular from those in Britain at the present time. Then, as now, dark Scotch firs clustered on the sands and gravels covering the heights of Kent, and alders and willows marked the water-courses of the low-lying district of Essex, until the view was closed northward by the black pines covering the answering heights of Havering and of Brentwood. We should alone miss the elms now so marked a feature in the landscape.

Such as these were the surroundings of the lion when he first appeared in Britain, huge in size and without a rival among the lower animals. The central figure, however, in the picture is proved by recent discoveries to have been man. Not only have flint implements of the ordinary river-drift type been obtained from the brick-earths of Crayford along with remains of the animals above mentioned, but Mr. Flaxman Spurrell has been able to fix the place where the hunter sat on the ancient bank of the Thames and fashioned the blocks of flint to his various needs. The river-drift hunter, armed with his roughly chipped stone implements, doubtless had great difficulty in making good his place in the struggle for existence among the beasts of prey then in the valley of the Thames, and sometimes, when he had the chance, he would be likely to eat the lion, and at other times the lion would certainly eat him. They must often have come into contact when engaged in the pursuit of the same animals.

The climate at this time in Southern Britain is proved to have been in the main temperate, by the presence of animals such as the horse, bison, and rhinoceros. A temperate fauna was then in possession of the land, although a few Arctic stragglers, such as the musk-sheep, were also present. The hippopotamus still haunted the banks of the Thames, and can hardly be supposed to have been able to endure the winter cold of the region now inhabited by the musk-sheep, any more than that animal could be expected to enjoy the heat of the summers in the present home of the hippopotamus.

The next question which presents itself is the geography of North-western Europe, while the above strange group of animals lived in Southern Britain. It is obvious from the fact of the above animals finding their way here that our island must then have formed part of the Continent. The fluviatile strata of Crayford have been met with at a depth of forty feet below high-water mark near Erith, so that then the whole lower portion of the Thames Valley was higher above the sea than it is now. The land, however, must have stood at a considerably higher level than that, since the soundings in the shallowest part of the Channel reveal a depth of about two hundred feet, and therefore an elevation of land of more than two hundred feet is necessary to allow of the migration of the lion and the other animals. The area now covered by the "silver streak" was then composed of forest-clad undulations, extending from the line of the chalk downs then reaching from Dover to Sangatte, in the Pas de Calais, on the one hand, northward into the fertile pastures now sunk beneath the North Sea, and on the other, to the southwest along the whole length of the Channel. Nor are we able to find evidence of the western sea-margin at this time till the hundred-fathom line is reached, which sweeps far to the west of Ireland, southward close into the shores of the Bay of Biscay, and northward so as to include the Hebrides and the Orkneys, forming a narrow fiord close to the present coast of Norway, that reaches as far as Denmark. The view of De la Bêche and Lyell, that all within this boundary was dry land, only broken by the rivers and the lakes, is most probably true. In this manner alone can we account for the presence of some of the above animals, such as the spotted hyena, in Ireland.

But when, it will be asked, were these things so? The answer is found in the fact of the presence of the living species of higher mammalia along with certain extinct species such as the mammoth, which points to one, and one only, stage in the evolution of animal life—that which is termed Pleistocene or Quaternary by the geologists, and further, to the middle stage of it, when temperate animals abounded and Arctic animals were rare in Southern Britain. The question is unanswerable if asked from the historical and not the geological point of view, because, outside the records in which the intervals between events are written down, we have merely a series of events which occurred in a certain order, without reference to lapse of time. An attempt to ascertain an historical date outside history is obviously idle, and is not furthered by an appeal to the present rate of the retrocession of waterfalls, or by speculations as to ancient changes in climate having been produced by changes in the relation of the earth to the sun. The events with which we are dealing—the conditions of life when the lion first appeared in Britain—are so far removed from the earliest records that we can not form an idea of the interval separating them from our own time. It must, however, have been very great to allow of the changes in climate and geography, and in the wild animals of Europe, as well as of the succession of the various races and the development of civilization, which, so far as our experience goes, could not have been swift.

The discoveries cited above prove that the lion and the river-drift hunter lived in the valley of the lower Thames, along with many animals now only to be found in temperate climates, with some which are now to be sought in warm climates, and with others that are extinct. We have noted also the presence of a few Arctic stragglers. In the long course of ages the climate gradually became colder in the valley of the Thames, and vast numbers of reindeer wandered over the area which had formerly been occupied by stags, uri, and the other animals already mentioned. Their remains lie scattered through the river gravels and loams at various heights above the level of the Thames, from Oxford and Abingdon down to London. The numerous remains, for example, found in digging the new cavalry barracks at Windsor, belonged one half to the reindeer and the rest to bisons, horses, bears, and wolves. They had evidently been washed down from a ford higher up stream, which these animals were in the habit of using year by year. The vast herds of migrating reindeer in Siberia and of bisons in North America cross the rivers very generally at the same points year after year, and are followed by the same kinds of beasts of prey, which bring up the rear and prey upon the stragglers. The lion, too, is proved, by the discovery of his remains in the gravel-beds of London along with reindeer, to have shared in the attack on the reindeer, horses, and bisons, as it is now to be seen among the antelopes in tropical Africa. Could we follow it to its haunts in the woodlands then occupying the site of London we should see it springing upon other animals, such as the Irish elk or the young of the woolly rhinoceros, mammoth, or hippopotamus. And could we penetrate to the banks of the streams, guided by a thin column of smoke rising above the tops of the trees at Hackney or Gray's Inn, we should come upon the rude shelters of the river-drift hunters—the men selecting blocks of flint and chipping implements out of them, the women preparing the meal of flesh, and the children looking on and breaking the silence of the evening with their shouts, on those very spots where now is to be heard day and night the voice of our great city. Man is here, as before, the rival of the lion in the chase.

The lion, along with the above-mentioned group of animals, has been discovered in the river deposits over the whole of Southern England, and as far to the north as Bielbecks in the North Riding of Yorkshire. It lived in the areas of Cambridge, Bedford, and Salisbury. It is, however, far more abundant in the caves, into which, in most cases, it has been dragged by the hyenas. The pack of hyenas inhabiting the Cave of Kirkdale, in the Vale of Pickering, fed upon reindeer in the winter, and at other times on horses and bisons, and were able to master the hippopotamus, the lion, the slender-nosed rhinoceros, or the straight-tusked elephant, and to carry their bones to their den, where they were found by Dr. Buckland. The hyenas also inhabiting "the Dukeries" dragged back to the dens fragments of lion. Here, too, our researches at Creswell revealed the presence of man. In the lower deposits in the caves were the characteristic implements of the river-drift hunter, while in the upper were the more highly finished stone weapons of the cave-man, along with articles made of bone and antler, such as a needle, and the earliest trace of artistic design in the figure of a horse incised on a polished fragment of bone. Here the wild animals were for the most part of the same species as those living in the area of London, and the same remark holds good of those found in the hyena-dens in the vale of Clwyd or on the banks of the Wye. The headquarters, however, of the lion in Britain were the Mendip Hills in Somersetshire, which overlooked the fertile tract which then extended from their foot under the present estuary of the Severn, and joined the great prairie sweeping up the English Channel, and far to the west of Ireland, and as far south as the mouth of the Garonne. Over this vast feeding-ground the lions followed the migrating herbivores, and Banwell, Bleadon, and Weston-super-Mare were their favorite haunts. They lay in wait in the passes of Cheddar and Burrington, and from time to time were surprised and overmastered by the hyænas on the banks of the Axe as it flowed through the picturesque ravine of Wookey.

On the Continent the lion ranged over France, Belgium, and Germany along with the above-described animals, and having the river-drift man first of all, and then the cave-man for its rivals. Evidence of this rivalry we have in a remarkable necklace found in the cave of Duruthy, in the district of the Adour in the western Pyrenees, consisting of forty canine teeth of bear and three of lion, adorned with incised figures—a harpoon, glove, fish, or seal. It is a magnificent trophy of the chase, buried along with the hunter in the floor of his dwelling, which proves that human art was more than a master for the claws and teeth of the most formidable beasts of prey—the lion and the cave-bear—then living in the southwest of France. The broken and burned bones on the floor point to the fact that reindeer, horses, bisons, and stags were then abundant in the neighborhood.

The fossil remains of the lion are found also in Italy along with the remains of living and extinct animals, such as the stag, Irish elk, and mammoth in strata of the Pleistocene age. Nor is the range of the lion confined merely to Europe at this time. An accumulation of fossil remains was discovered many years ago in the United States, in the valley of the Ohio, a few miles southwest of Cincinnati, in Boone County, Kentucky, so great that it is known as Big Bone Lick. The animals to which they belonged had been attracted to the morass in which they perished by a deposit of salt, and present the same association of living and extinct forms as we have observed in Europe. Reindeer, musk-sheep, bisons, horses, elks, and bears were to be seen along with the mammoth, the great elephant-like mastodon, and the gigantic extinct sloth of South America. A lower jaw found in the same place, which I have examined in Philadelphia, leaves no doubt in my mind that the lion was among the carnivores of the United States, which lived on the above-mentioned animals. It is not more strange that the lion of the Old World should be found in the New, than that the musk-sheep, now only alive in the Arctic regions of North America and Greenland, should have ranged through Siberia into Europe as far to the southwest as the Pyrenees. Asia was then united to Northeastern America, and the Straits of Behring were then an elevated tract of land offering free passage to migrating animals.

Thus far in our inquiry into the British lion, we have been led to consider a condition of things in Britain quite different from that of the present day, and in tracing the animal to the Continent, and finally to the United States, we have seen that tracts of land, now sunk beneath the sea, connected our islands with the Continent, and joined North Asia to North America. It must also be remarked that the lion appears in the Old and New Worlds at the same hour, if I may use the metaphor, of the geological clock, when "the old order" was yielding "place unto the new," and the living species were becoming more abundant than the extinct among the higher mammalia —in other words, in the Pleistocene age.

We have now to direct our attention to the retreat of the lion from Europe. At the close of the Pleistocene age the great extension of Europe to the west sank beneath the Atlantic, and the North Sea and the English Channel flowed over the hunting-grounds of the lion, and formed "the silver streak" of which we have so much reason to be proud. A change in the wild animals accompanied, as it always does, the change in geography; some animals became extinct, such as the mammoth, while others retreated to more congenial districts, and among them the lion. Not a trace of that animal has been discovered in the peat-mosses and other superficial accumulations in Britain, France, Germany, or Italy, which took place in the prehistoric age, or the interval between the Pleistocene on the one hand and the frontier of history on the other. It was probably at this time retiring southward into the districts in which it lived in the time of the early Greek writers.

The first discovery on record of the fossil lion was made in Hungary. Strange to say, the earliest notice of the living lion relates to the adjacent region divided from the valley of the Danube by the Balkan Mountains. Herodotus (vii, c. 124–'6), in describing the march of Xerxes through Roumelia, before the battle of Thermopylæ, writes:

While Xerxes was on the march in this direction lions fell upon the baggage-camels. They came down by night and left their usual haunts, and touched nothing else, neither beast of burden nor man, but killed the camels only. I wonder why on earth they should have abstained from the other animals and attacked the camels only, beasts that they had never seen or tasted before. There are in this district *many lions* and wild oxen with large horns (*uri*), which the Greeks obtain from the inhabitants by barter. The boundary of the district inhabited by the lions is the river Nestus (Carasu) that flows through Abdera, and the Achelöus, that flows through Acharnania: for neither to the east of the Nestus is there a lion anywhere in that part of Europe, nor to the west of the Achelöus in the rest of the continent, but it lives only in the district between those rivers.

It must be remarked that in this precise account Herodotus, with his usual accuracy, defines only the eastern and western boundaries, which he knew, and says nothing about the unknown region to the north. The story of the lions was still fresh in the memory of the hunters of Chalkidike when it was picked up by Herodotus in his travels some twenty-five years afterward, and used to light up his narrative. It is certain, then, that the lion lived in B. C. 480 in the forests south of the Balkans, between these two boundaries, and probably as far south as the Gulf of Lepanto and the Isthmus of Corinth. It probably ranged also northward into the valley of the Danube.

We are indebted to Xenophon, about a hundred years later, for the next mention of the lion in Europe. In his "Treatise on Hunting" (xi, i), which he wrote on his banishment from Athens in his splendid retreat in Lacedæmon, after he had exchanged the court and the camp for the pleasures of gardening and hunting, he says: "Lions, pardaleis" (probably a leopard), "lynxes, panthers, bears, and such like beasts, are caught in foreign countries in the neighborhood of Mount Pangæum, and Mount Cissus, which is beyond Macedonia, and in the Mysian Olympus and in Pindus, and in Nyse that is above Syria, and in other mountains that can support such animals." Mount Pangæum is near the sources of the Nestus, and Cissus is close to Thessalonica, and therefore this passage strongly confirms the truth of the story told by Herodotus. It is, however, rejected by Baron Cuvier and Sir G. C. Lewis, on the grounds that all these animals are not likely to have lived in any one of the above localities, and that it is a general statement relating to Europe and Asia Minor. Taken along with the statement of Herodotus, and the further fact that the lynx and bear still live in the same region, it seems to me that Xenophon knew what he was writing about when he advised the hunters to capture the above animals by the use of poisoned meat in those districts. Whether Xenophon's advice was taken or not, we find in the pages of the next writer, some fifty years afterward, that the lions were becoming rare in Europe. Aristotle describes their range nearly in the same words as Herodotus, but in the interval of a hundred and fifty years the "many lions" (πολλοὶ λέοντες) of the one had become "the few" (σπάνιον λένος) of the other, and they had by that time been driven to their last foot-hold in Europe by the hunter and the husbandman. The exact date of the killing of the last lion is uncertain; but from the melancholy passage of Dio Chrysostom Rhetor (Oratio 21)—"the honorable have vanished away in the course of time, as they say the lions have done which formerly dwelt in Europe"—it must have happened before the close of the first century after Christ.

Sir G. C. Lewis, to whose papers in "Notes and Queries" we are indebted for many references used in this essay, points out that the mythology of Italy contains no allusion to the lion, while that of Greece extends the range of the lion into Peloponnese, and to the west of the Achelöus, or, in other words, proves that the lion had a wider range in Southern Europe before the time of Herodotus than it had afterward. According to Ælian, it had retired from Peloponnese before the time of Homer.

The memory of the lion was preserved in its ancient haunts long after it had become extinct. The scene of one of the prettiest stories told by Ælian * is laid in Mount Pangæum, which, from its mention by Xenophon, must have been a famous haunt of lions:

Eudemus tells the tale that in Pangæum in Thrace a bear attacked the lair of a lion, while it was unguarded, and killed the cubs that were too small and too weak to defend themselves. And when the father and the mother came home from hunting somewhere, and saw their children lying dead, they were much aggrieved, and attacked the bear; but she was afraid, and climbed up into a tree as fast as she could, and settled herself down, trying to avoid the attack. Now, when they saw that they could not avenge themselves on her, the lioness did not cease to watch the tree, but sat down in ambush at the foot, eying the bear, that was covered with blood. But the lion, as it were, without purpose and distraught with grief, after the manner of a man, rushed off to the mountains, and chanced to light on a wood-cutter, who, in terror, let fall his axe; but the lion fawned upon him, and reaching up saluted him as well as he could, and licked his face with his tongue. And the man took courage. Then the lion encircled him with his tail, and led him, and did not suffer him to leave his axe behind, but pointed with his foot for it to be taken up. And when the man did not understand he took it up in his mouth and reached it to him. Then he followed while the lion led him to his den. And when the lioness saw him, she came and made signs, looking at the pitiable spectacle, and then up at the bear. Then the man perceived and understood that the lion had suffered cruel wrong from the bear, and cut down the tree with might and main. And the tree fell, and the lions tore the bear in pieces; but the man the lion led back again, safe and sound, to the place where he lighted on him, and returned him to the very tree he had been cutting.

With this simple story, told probably by the wood-cutters of Pangæum to their children and handed down from generation to generation, we may conclude the history of the lion in Europe. In the remote Pleistocene age the lion ranged over nearly the whole of Europe, south of a line passing through Yorkshire and the Baltic, over

* "De Natura Animalium," iii, 21.

the United States, and consequently also over the intervening continent of Northern Asia, when the climate and geography were different from what they are now. From the close of that age, marked in Britain by the development of "the silver streak," the animal has steadily been retreating southward in the direction of its present haunts through all the period recorded in history. This has probably been brought about by the rivalry of the hunter, the loss of cover, and the increasing scarcity of game. Its disappearance, however, from Northern Asia and North America must have been due to some other causes, as in the parallel case of the horse, which abounded in North America in the Pleistocene age, and afterward became extinct, although the conditions of life are now so favorable that the animals introduced by the Spaniards have run wild, and now form vast herds. It became extinct in Britain at the close of the Pleistocene age, and in Europe between the time of Aristotle (340 B. C.) and that of Dio Chrysostom Rhetor (80 to 100 A. D.).—*Contemporary Review.*

SCIENTIFIC FARMING AT ROTHAMSTED.

By MANLY MILES, M. D.

IN the literature of every department of agriculture, the references to the Rothamsted experiments are getting to be as familiar as household words, and it is now generally admitted that they have had an important influence on English farm-practice.

In this country, however, the direct and practical bearing of these experiments on the every-day business of the farm is not fully appreciated, and this is perhaps largely owing to the fact that the American farmer is owner of the soil he tills, and is not therefore compelled to give that strict attention to every detail of the economy of farm management that is essential to the successful practice of farming in Great Britain.

It would seem that the leading object of inquiry at Rothamsted has been the solution of agricultural problems, but the relations of science to agriculture are so broad that what may be considered purely practical lines of investigation can not be limited to considerations that are of interest to the farmer only, as they involve the discussion of questions that are constantly presenting themselves in the progressive development of the sciences of chemistry, botany, vegetable and animal physiology, including dietetics and the laws of assimilation and growth, and thus lead to an examination of topics that are properly included in the domain of social and sanitary sciences.

In fact, when the original object of inquiry is the attainment of some practical end, the dominant work of experimentation, when properly conducted, soon comes to be the investigation of special questions that strictly pertain to some department of the allied sciences.

In the well-planned experiments which have been so ably conducted at Rothamsted for more than forty years, embracing a wide range of topics, there is an abundant fund of information that must be of interest not only to the farmer, who looks for results in pecuniary values, but to the man of science, seeking the truth for the truth's sake, and the intelligent general reader who wishes to trace understandingly some of the leading facts in the world's progress.

Without including numerous newspaper articles, and the annual "Memoranda of the Experiments at Rothamsted," that have been printed for several years for the convenience of visitors, nearly one hundred elaborate papers and discussions of the field, feeding, and laboratory experiments, many of which are in the form of monographs, have been published since 1847, every one of which has had its influence on questions of agricultural practice, as well as on the various theories in science that have been prominent for the past half-century.

These papers are to be found in the "Journal of the Royal Agricultural Society," the "Reports of the British Association for the Advancement of Science," the "Journal of the Chemical Society of London," the "Proceedings and Transactions of the Royal Society of London," the "Journal of the Society of Arts," the "Journal of the Horticultural Society of London," the "Reports of the Royal Dublin Society," the "Edinburgh Veterinary Review," the "Philosophical Magazine," and other periodicals, and in official reports on special subjects of investigation.

The titles alone of these papers would require the space of several pages of this magazine.

Rothamsted, with its fine old manor-house, the home of Sir John Bennet Lawes, is in Hertfordshire, England, about twenty-five miles from London, on the Midland Railway, Harpenden Station.

Mr. Lawes was born in 1814, and succeeded to his estate in 1822. He was educated at Eton, and at Brasenose College, Oxford. After leaving the university, in 1835, he spent some time in London, in the study of chemistry, which had been a subject of special interest to him when pursuing his academic course.

Soon after taking possession of his hereditary property at Rothamsted, in 1834, he began a systematic course of experiments with different fertilizers, first with plants in pots, and afterward in the field.

"The researches of Dr. Saussure on vegetation were the chief subjects of his study to this end. Of all the experiments so made, those 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, gave the most striking results.

"The results obtained on a small scale in 1837–1839 were such as to lead to more extensive trials in the field in 1840 and 1841, and subsequently."

Dr. J. H. Gilbert has been associated with Mr. Lawes since June, 1843, and has had the direction of the laboratory.

"In 1843 more systematic field experiments were commenced; and a barn, which had previously been partially applied to laboratory purposes, became almost exclusively devoted to agricultural investigations. The foundation of the Rothamsted Experiment Station may be said to date from that time (1843). The Rothamsted Station has, up to the present time, been entirely disconnected from any external organization, and has been maintained entirely by Mr. Lawes. He has further set apart a sum of £100,000 and certain areas of land for the continuance of the investigations after his death."

In 1854 a subscription was made by agriculturists for a testimonial to be presented to Mr. Lawes as an expression of their appreciation of the great value of the services he had rendered to British agriculture. The committee in charge of this fund, instead of expending it in plate as had been intended, devoted it, at the suggestion of Mr. Lawes, to the erection of a new laboratory, so that the facilities for experimenting were largely increased.

The eminent services of Drs. Lawes and Gilbert, in the improvement of agriculture and the advancement of science, have been repeatedly recognized. In 1854 Dr. Lawes was elected a Fellow of the Royal Society, and in 1867 the royal medal was awarded to him conjointly with Dr. Gilbert, by the council of the society. The gold medal of the Imperial Agricultural Society of Russia was awarded to Dr. Lawes, and last year the Emperor of Germany, by imperial decree, awarded the gold medal of merit for agriculture to Dr. Lawes and Dr. Gilbert jointly, "in recognition of their services for the development of scientific and practical agriculture."

As a national recognition of the great value of the investigations to which he has devoted his life, Dr. Lawes has this year been created a baronet.

The number of assistants engaged in the work of experimenting has gradually increased. At first only one laboratory-man was employed, but soon a chemical assistant was needed, and then a computer and record-keeper.

"During the past twenty-five years the staff has consisted of one or two and sometimes three chemists, and two or three general assistants, one of whom is generally employed in routine chemical work, but sometimes in more general work."

The general assistants superintend the experiments with animals and the field experiments—the making of manures and their application—the harvesting and weighing of the crops—the selection of samples which are prepared for preservation or analysis, and they also make determinations of dry matter, ash, etc.

"There are now more than thirty thousand bottles of samples of experimentally grown vegetable produce, of animal products, of ashes, or of soils, stored in the laboratory. A botanical assistant is also occasionally employed, with from three to six boys under him, and with him is generally associated one of the permanent general assistants, who at other times undertakes the botanical work." Several computers and record-keepers have for some time past been occupied in calculating and tabulating the field, feeding, and laboratory results. Additional chemical assistance is frequently engaged in London and elsewhere. Professor Way, Dr. Frankland, and Dr. Voelcker, have done more or less work on material obtained at Rothamsted, and their published reports are of great interest. Mr. R. Richter, of Berlin, has for some years past been almost constantly occupied with analytical work sent from Rothamsted. A considerable, but of course varying, force of agricultural laborers find employment in the field-work.

"The general scope and plan of the field experiments has been to grow some of the most important crops of rotation, each separately, year after year, for many years in succession on the same land, without manure, with farm-yard manure, and with a great variety of chemical manures; the same description of manure being, as a rule, applied year after year on the same plot. Experiments on an actual course of rotation, without manure and with different manures, have also been made. In this way experiments have been conducted as follows:

"With wheat, thirty-nine years in succession: thirteen acres, thirty-seven plots, many of which are duplicates of others. On barley, thirty-one years in succession: four and a half acres, twenty-nine plots. On oats, ten years (including one year fallow): three quarters of an acre, six plots. On wheat, alternated with fallow, thirty-one years: one acre, two plots. On different descriptions of wheat, fifteen years: four to eight acres (each year in a different field), now more than twenty plots. On beans, thirty-two years (including one year wheat, and five years fallow): one and a quarter acre, ten plots; also twenty-seven years: one acre, five plots. On beans, alternated with wheat, twenty-eight years: one acre, ten plots. On clover, with fallow or a grain-crop intervening, twenty-six years: three acres, eighteen plots. The land is now devoted to experiments with various leguminous plants, commenced in 1878. On turnips, twenty-eight years (including three years barley): about eight acres, forty plots. On sugar-beets, five years: about eight acres, forty-one plots. On mangold-wurzel, seven years: about eight acres, forty-one plots. On potatoes, seven years: two acres, ten plots. On rotation, thirty-five years: about two and a half acres, twelve plots. On permanent grass-land, twenty-seven years: about seven acres, twenty-two plots.

"Comparative experiments, with different manures, have also been made on other descriptions of soil, in other localities. Samples of all the experimental crops are taken, and brought to the laboratory.

Weighed portions of each are partially dried, and preserved for future reference or analysis. Duplicate weighed portions of each are dried at 100° C., the dry matter determined, then burned to ash on platinum sheets in cast-iron muffles. The quantities of ash are determined and recorded, and the ashes themselves are preserved for reference or analysis. In a large proportion of the samples the nitrogen is determined, and in some the amount existing as albuminoids, amides, and nitric acid.

"In selected cases—illustrating the influence of season, manures, exhaustion, etc.—complete ash-analyses have been made, numbering in all more than seven hundred. Also in selected cases, illustrating the influence of season and manuring, quantities of the experimentally grown wheat-grain have been sent to the mill, and the proportion and composition of the different mill-products determined.

"In the sugar-beet, mangold-wurzel, and potatoes, the sugar in the juice has in most cases been determined by the polariscope, and frequently by copper also.

"In the case of the experiments on the mixed herbage of permanent grass-land, besides the samples taken for the determination of the chemical composition (dry matter, ash, nitrogen, woody fiber, fatty matter, and composition of ash), carefully averaged samples have frequently been taken for the determination of the botanical composition. In this way, on four occasions, at intervals of five years—viz., in 1862, 1867, 1872, and 1877—a sample of the produce of each plot was taken and submitted to careful botanical separation, and the percentage, by weight, of each species in the mixed herbage determined. Partial separations, in the case of samples from selected plots (frequently of both first and second crops), have also been made in other years."

This condensed statement of the plan of the field experiments, and brief outline of some of the work performed in connection with them, from the "Memoranda" for June, 1882, will give some general idea of the extent of the Rothamsted Station, and of the thorough manner in which all operations are conducted; but, in our enumeration of the other lines of inquiry now in progress, we can only mention the subjects of investigation without referring to particulars in the methods practiced, as we wish to save space for a discussion of some of the leading results that have been thus far obtained.

More than one thousand samples of soil have been taken from the experiment-plots, at different depths, for the purpose of analysis, to ascertain the rate of soil-exhaustion under different conditions, and to trace the relations of the soil to the crops grown and to the manures applied.

For nearly thirty years the rain-fall has been measured in a gauge having an area of one thousandth of an acre, and frequent analyses have been made to determine the available supply of combined nitrogen in the form of ammonia and nitric acid that can be obtained by plants from this source. In some cases the chlorine has also been determined. The absorptive capacity of soils and subsoils for water and ammonia has likewise been investigated.

The quantity and composition of drainage-waters under various conditions have been the subject of elaborate and extended experiments for many years, and the results obtained are of the greatest importance.

In 1870 three "drain-gauges" were made, each having an area of one thousandth of an acre, and inclosing the soil and subsoil in a natural state of consolidation to the depth of twenty, forty, and sixty inches, respectively. As the surface-soil in these gauges is kept free from vegetation, and no fertilizers are applied, their drainage represents, in effect, that of a bare, unmanured fallow. In the separate drains of the permanent wheat-plots facilities were provided for collecting samples of drainage-water from soils growing crops without manure, with barn-yard manure, and with a great variety of chemical manures.

Determinations of the nitrogen in rain-water were made at Rothamsted as early as 1846. The ammonia in the rain-fall for fifteen months, in 1853–'54, was determined in the laboratory at Rothamsted, and again in 1855–'56 by Professor Way. Dr. Frankland made analyses of the rain-fall, and also of dew and hoar-frost in 1869–'70, since which time a series of systematic investigations have been conducted in the Rothamsted laboratory.

A large number of samples of the drainage-waters from the experimental wheat-field were analyzed by Dr. Voelcker, the able chemist of the Royal Agricultural Society, and by Dr. Frankland, previous to 1875, while over thirteen hundred samples have been analyzed since that time at Rothamsted. The drainage of the "drain-gauges," from 1870 to 1874, was analyzed by Dr. Frankland, and since that date it has been systematically investigated at Rothamsted.

A full report of these drainage experiments is given in an elaborate paper "On the Amount and Composition of the Rain and Drainage-Waters collected at Rothamsted," published in the last three numbers of the "Journal of the Royal Agricultural Society" (1881–'82), which, from its direct applications to questions of farm-practice, and the light it throws upon the obscure subject of soil-exhaustion and on the economy of manures, is undoubtedly the most valuable contribution to agricultural science that has appeared for many years.

Experiments were made for several years with plants representing the gramineous, the leguminous and other families, and also with evergreen and deciduous trees, to ascertain the amount of water given off during their growth.

Observations on the character and range of the roots of different plants, the relative development of leaf and stem, and their composition at various stages of growth, have been made in connection with experiments to determine the differences in the amount and constituents assimilated by plants of different botanical families, under similar conditions, and of the same plant under varying conditions. From these investigations, so far as they have been published, it appears that the chemical relations of the plant and soil are, to a great extent, determined by botanical and physiological conditions.

In the experiments with the mixed herbage of "permanent meadow," for example, it was noticed, even in the first years of the experiments, that "those manures which are most effective with wheat, barley, or oats grown on arable land—that is, with the gramineous species grown separately—were also the most effective in bringing forward the grasses proper in the mixed herbage; and again, those manures which were the most beneficial to beans or clover, most developed the leguminous species of the mixed herbage, and *vice versa.*"

In the produce grown continuously *without manure* the average number of species was forty-nine. Of these seventeen are grasses, four leguminous species, and twenty-three of other orders. By weight the grasses averaged sixty-eight per cent, leguminous species nine per cent, and species of other orders twenty-three per cent.

In the produce of the plot most *heavily manured* and yielding the heaviest crops, the average number of species was nineteen; of which twelve to thirteen were grasses, one only (or none) leguminous, and five or six only of other species. By weight the grasses averaged about ninety-five per cent, the leguminous species less than 0·01 per cent, and other orders less than five per cent.

On the plot receiving annually manures that are of little avail for gramineous crops grown separately in rotation, but which favor beans or clover so grown, the average number of species was forty-three, of which seventeen were grasses, four leguminous, and twenty-two belonging to other orders. But by weight the grasses averaged but from sixty-five to seventy per cent, the leguminous species nearly twenty per cent, and all other species less than fifteen per cent.

The "struggle for existence" and the "survival of the fittest," therefore, determine the character of the species contained in the produce under the conditions, and the chemical composition of the crop varies accordingly. With an increase of the leguminous produce the nitrogenous constituents are increased, and with a decrease in the leguminous produce the nitrogenous constituents are diminished.

Experiments with leguminous, gramineous, and other families of plants were made for several years in succession, at Rothamsted, to determine whether plants assimilate free or uncombined nitrogen.

The relations of nitrogen to the growing plant and to the soil and the sources of the nitrogen of vegetation have been prominent subjects of investigation in all the Rothamsted field-experiments.

It is not my purpose, in this connection, to discuss the various theories of vegetable growth, or to give an account of the many controversies that have arisen in the developmental progress of science, but simply to call attention to some of the leading lines of investigation at Rothamsted which have had an influence in correcting our theories of vegetable nutrition and soil-exhaustion and in improving our methods of agricultural practice.

The legitimate aim of all systematic, exact experiments is to lay a foundation of well-ascertained and closely related facts on which may be developed a superstructure of science to supersede the theoretical speculations which form an important part of the prelude of scientific discovery. In this work of reconstruction, Drs. Lawes and Gilbert have for many years occupied a prominent position, and a full account of their labors would involve in the record a history of agricultural science for the past half-century.

From an agricultural stand-point one of the first steps in the study of the laws of plant growth and nutrition is to ascertain the relative influence of the soil and the air in the supply of plant-food, as they are the only sources from which plants obtain the elements which enter into their composition.

The atmosphere is a mixture of gases, of which more than three fourths is nitrogen, and less than one fourth oxygen, with something less than one part in ten thousand of carbonic acid. In addition to these there are traces of ammonia and a variable quantity of vapor of water.

As the carbon, which forms about one half of the dry substance of plants, is all derived from the minute proportions of carbonic acid found in the atmosphere, it has been assumed that the comparatively small amount of nitrogen required by plants could be readily obtained from the abundant stores of this element in the atmosphere, and that wide-leaved plants, like clover and beans, could more readily assimilate it than those with narrow leaves, like the grasses.

Experiments by Boussingault and the elaborate researches at Rothamsted, however, show that free nitrogen, the most abundant constituent of the air, is not assimilated by plants. The atmospheric sources of nitrogen for plant-growth must, therefore, be limited to the minute quantities of combined nitrogen in the form of ammonia and nitric acid.

Important data as to the amount of nitrogen in various field-crops, grown under a variety of conditions, and the sources from which it is obtained, are furnished in the Rothamsted field-experiments.

For a period of thirty-two years, wheat, on plots without manure, yielded an annual average of 20·7 pounds of nitrogen per acre. The yield, however, declined from an average of more than twenty-five pounds during the first eight years to an average of but sixteen pounds during the last eight years of the experiment.

Barley, for a period of twenty-four years, on plots without manure, yielded annually an average of 18·3 pounds of nitrogen per acre, with a decline from an average of twenty-two pounds over the first twelve years to an average of 14·6 pounds over the next twelve years. Mineral manures, containing no nitrogen, applied to barley and wheat did not materially increase the yield of nitrogen in the crop.

A succession of root-crops (with three years of barley intervening after the first eight years), dressed with a complex mineral manure, yielded an average of 26·8 pounds of nitrogen per acre, per annum, over a period of thirty-one years; with a decline from an average of forty-two pounds over the first eight years to 13·1 (in sugar-beets) over the last five years. Afterward, with the change of crop to mangolds, the yield of nitrogen was somewhat increased.

Beans, for a period of twenty-four years, yielded an average of 31·3 pounds of nitrogen without manure; and, with a complex mineral manure, an average of 45·5 pounds of nitrogen per acre. The decline in yield of nitrogen was, however, from an average of 48·1 pounds over the first twelve years to only 14·6 pounds over the last twelve years, when unmanured, and from an average of 61·5 pounds over the first twelve years to but 29·5 pounds over the last twelve years, when mineral manures were applied.

An annual average yield of nearly two hundred pounds of nitrogen per acre was obtained in the clover grown for twenty-seven years in succession on a plot of old garden-soil that was exceptionally rich in nitrogen at the beginning of the experiment. As in the case of other crops, there was a marked decline in the average yield of nitrogen in the last half of the period, and there was also a great reduction in the stores of nitrogen contained in the soil.

The leguminous crops, beans and clover, it will be seen, contain a larger amount of nitrogen per acre than the gramineous crops, wheat and barley. In the Rothamsted experiments it was, however, found that manures containing nitrogen benefited the gramineous crops, while they had but little, if any, influence upon the growth of leguminous crops. The chemical composition of the crop was not, therefore, an index of the manurial constituents required to promote its growth.

When turnips, barley, clover, or beans, and wheat were grown in rotation for twenty-eight years, the average annual yield of nitrogen per acre was 36·8 pounds, and in the mixed herbage of permanent grass-land, when unmanured, the annual yield of nitrogen averaged thirty-three pounds per acre.

The larger average yield of nitrogen per acre in the crops in rotation and in the mixed herbage of the permanent grass-land, as compared with the yield of nitrogen in gramineous crops when grown separately, is not entirely due to the larger amount of nitrogen in the leguminous species themselves, but also to their influence upon the gramineous species which are able to take up and assimilate more nitrogen when the highly nitrogenous leguminous crops have been appropriating their larger supplies of the same element, as will be seen from the following experiments:

"In alternating wheat and beans, the remarkable result had been obtained that nearly as much wheat and nearly as much nitrogen were yielded in *eight* crops of wheat in alternation with the highly nitrogenous beans as in *sixteen* crops of wheat grown consecutively without manure in another field, and also nearly as much as were obtained in a third field in eight crops, alternated with a bare fallow."

And again: "After the growth of six grain-crops by artificial manures alone, the field so treated was divided, and in 1873 on one half barley, and on the other half clover, was grown. The barley yielded 37·3 pounds of nitrogen per acre, but the three cuttings of clover yielded 151·3 pounds. In the next year, 1874, barley succeeded on both the barley and the clover portions of the field. Where barley had previously been grown, and had yielded 37·3 pounds of nitrogen per acre, it now yielded 39·1 pounds; but where the clover had previously been grown, and had yielded 151·3 pounds of nitrogen, the barley succeeding it gave 69·4 pounds, or 30·3 pounds more after the removal of 151·3 pounds in clover than after the removal of only 37·3 pounds in barley."

We will now examine some of the evidence furnished by the Rothamsted experiments, in regard to the sources from which the nitrogen of field-crops is obtained.

As free or uncombined nitrogen cannot, as we have seen, be assimilated by plants, we will next consider the supply of combined nitrogen in the form of ammonia and nitric acid, existing in the atmosphere.

From the earlier investigations of the rain-fall at Rothamsted and likewise on the Continent, it was estimated that from eight to ten pounds of combined nitrogen per acre was precipitated annually in the rains of Western Europe. Later observations at Rothamsted show that this estimate is probably too high, and Drs. Lawes and Gilbert, after a full discussion of their records for twenty-seven years, fix the probable amount at four to five pounds per acre.

As this is only one fourth of the average annual yield of nitrogen per acre of the unmanured wheat over a period of thirty-two years, and but little more than one fourth of the average annual yield obtained with barley over a period of twenty-four years, to say nothing of the much larger yield of nitrogen in leguminous crops, it must be admitted that it is an entirely inadequate source of supply of nitrogen for vegetation. The nitrogen condensed by the soil from dew and atmospheric vapor has not been definitely determined, and is not, therefore, included in this estimate; but it is probable that it is less than that brought to the soil by the rain. On the other hand, it has been shown by numerous experiments, including those at Rothamsted, that free nitrogen is evolved in the decomposition of organic matter, and that the soil, under certain conditions, may suffer a loss of nitrogen in this form.

Of the rain falling upon the drain-gauges, the unmanured soil of which, it will be remembered, is in a natural state of consolidation and kept free from vegetation, for a period of ten years, about forty-four per cent has appeared as drainage-water, and about fifty-six per cent has been evaporated. Approximately, two thirds of the evaporation takes place during the summer months, and one third during the winter months.

The annual loss of nitrogen in the drainage-water has been, upon the average, at the rate of 43·7 pounds per acre. This represents, approximately, the loss involved under the conditions of a bare summer fallow.

When the roots of growing plants are distributed through the soil, they take up the nitrogen as it becomes soluble in the process of nitrification, and the loss by drainage is to that extent diminished.

The drainage from the unmanured wheat-plots contained nitrogen at the rate of only from 12·56 to 18·62 pounds per acre each year, and during two seasons of excessive drainage, when every running from the drains was analyzed, "it was estimated that from fifteen to seventeen pounds of nitrogen were lost per acre, per annum, by drainage from plots which had received no nitrogenous manure for many years," and the average for thirty years was from ten to twelve pounds per acre. During its period of active growth, the crop appropriated the nitrogen of the soil, so that there was little or none lost by drainage, and nearly the entire loss took place after harvest, and during the winter and spring months.

The nitrogen lost by drainage on land receiving no nitrogenous manure is therefore considerably more than can reasonably be estimated in the supply from atmospheric sources.

When nitrogenous manures were applied, the loss of nitrogen by drainage was materially increased, and on the average for more than thirty years, and under the most favorable conditions of growth, less than one third of the nitrogen applied as manure was recovered in the increase of the crops, and much less than this when there was a deficiency of potash or phosphoric acid in the soil.

In connection with these facts, relating to the amounts of nitrogen removed in the crops and lost by drainage, and the inadequate supplies of available atmospheric nitrogen for the purposes of plant-growth, it becomes a matter of particular interest to trace the influence of this system of continuous cropping, without nitrogenous manures, upon the nitrogen contained in the soil itself.

The nitrogen in the soil of the unmanured wheat-plots has gradually diminished, and Dr. Gilbert says, "So far as we are able to form a judgment on the point, the diminution is approximately equal to the nitrogen taken out in the crops, and the amount estimated to be received in the annual rain-fall is approximately balanced by the amount lost by the land, as nitrates in the drainage-water."

Where the great decrease in the yield of nitrogen was observed, in the case of the root-crops which were grown for thirty-one years in succession, the soil at the end of twenty-seven years was found to contain a smaller percentage of nitrogen than any other arable land of the farm.

In the experiments on the mixed herbage of permanent grass-land, "the soil of the plot which, under the influence of a mixed mineral manure, including potash, had yielded such a large amount of leguminous herbage, and such a large amount of nitrogen, showed, after twenty years, a considerably lower percentage of nitrogen than that of any other plot in the series."

The soil of the garden-plot, which gave so large a yield of clover over a period of twenty-seven years, was analyzed at the end of twenty-six years, and Dr. Gilbert remarks, in regard to the loss of the nitrogen of the soil, that "the diminution, to the depth of nine inches only, represents, approximately, three fourths as much as the amount estimated to be taken in the clover in the intervening period; and the indication is, that there has been a considerable reduction in the lower depths also."

When nitrogenous manures were applied in the form of ammonia salts or nitrate of soda there was little or no decrease in the nitrogen of the soil, and in some cases there was an actual gain; but the loss from drainage was much greater, and it increased with each increment of the manures applied under the same conditions. On plots receiving 43, 86, and 129 pounds, respectively, of nitrogen in the form of ammonia salts, mostly applied in the autumn, the estimated loss of nitrogen by drainage was 19, 31, and 42·4 pounds; "and with 86 pounds of nitrogen applied without, or with different mineral manures, the estimated loss ranged from 31 pounds with the most liberal manure to 43·2 pounds with the ammonium salts continuously used alone."

The nitrogen of barn-yard manure, which from its comparative insolubility is more slowly available for purposes of plant-growth, was not lost by drainage to the same extent as the chemical manures, and there were decided indications of considerable accumulations of it in the soil. The nitrogen applied in manures is not all accounted for in the amounts removed in the crop, lost by drainage, and stored up in the soil; and it therefore seems probable, in the absence of any other known disposition of it, that the estimated losses by drainage, based on the materials discharged by the tile-drains, are altogether too low. As the drainage-waters, with the substances they hold in solution, pass from the upper to the lower strata of the soil, we can not avoid the conclusion that a large proportion must pass below the level of the drains without entering them. The drains of the experimental wheat-fields are nearly twenty-five feet apart, and the underlying chalk at the depth of from ten to fourteen feet furnishes good drainage for the spaces between the drains.

The nitrogen applied in the manures that is not taken up by the crop or stored up in the soil, or lost in the waters discharged by the tile-drains, may therefore be fully accounted for in the amount that must be carried, under the conditions of the experiments, by the drainage-waters to the lower strata of the subsoil, without entering the drains. The estimated losses of nitrogen by drainage, based on the amounts detected in the waters discharged by the drains, may therefore with good reason be increased by the amount not accounted for in the crop and in the accumulations of the soil.

Practically, then, in the light of the Rothamsted experiments, we may look upon the soil as the great source of the nitrogen of plants, as the atmosphere can furnish but a small proportion of the needed supply, and this is more than counterbalanced by the losses from drainage.

In connection with this imperfect outline of some of the leading lines of investigation that have been so successfully prosecuted at Rothamsted, it would be interesting to examine the data that indicate the relations of nitrogen to other elements of plant-growth, as supplied in manures and assimilated by crops when cultivated in succession or in rotation with other species ; but these, with other cognate topics, must be omitted, as we can not at this time undertake anything like an exhaustive discussion of the results of these valuable experiments.

The great importance of physiological researches and the comparatively subordinate influence of purely chemical methods in solving the great problems of agricultural science, have been so fully illustrated in the experiments at Rothamsted that we must accept them as the basis of a new departure in the development of a consistent science of rural economy. In the light of these experiments the generally accepted theories of soil-exhaustion must be reconstructed, and the action and relative value of manures must be investigated from a new stand-point.

The exhaustion of a soil can no longer be estimated by the constituents removed in the crop. Wheat and oats, with other cereals, are generally considered as exhausting crops, and a summer fallow is looked upon as a means of increasing or restoring the fertility of the soil ; but the grain-crops when grown by themselves, and the summer fallow itself, are alike the occasion of a loss of fertilizing materials, and in precisely the same way. In both cases there is a long interval in which there are no living roots of plants in the soil to take up the nutritive materials as they are transformed into the soluble form, and they are lost by percolation to the lower strata of the subsoil out of the reach of vegetation.

Many of what are called restorative plants feed in the deeper layers of the soil, and they may, by their scattered foliage and thick roots, add to the stores of plant-food in the surface-soil, which may be used by plants of a different habit that are not deep feeders.

The physiological peculiarities of the different botanical groups of plants must, however, be better understood before we can fully explain the influence of one crop upon another that succeeds it. That the special formula manures, so widely advertised in this country, and which are claimed to provide, in due proportion, the constituents required by a particular crop, are based on false assumptions, is abundantly shown in the Rothamsted field-experiments; but we can not now discuss the fallacy in detail.

The experiments with animals at Rothamsted must form the subject of a separate article.

WHO WAS PRIMITIVE MAN?

By Professor GRANT ALLEN.

WHEN Sir Charles Lyell's "Antiquity of Man" and Mr. Darwin's two great works first set all the world thinking about the origin of our race, there was a general tendency among scientific men and the public generally to take it for granted that the earliest known men, those whose remains we find in the river-drift, were necessarily "missing links" between the human species and its supposed anthropoid progenitors. People naturally imagined that these very ancient men must have been hairy, low-browed, semi-brutal savages, half-way in development between the gorilla and the Australian or the Bushman. Striking word-pictures painted the palæolithic hunter for us as an evolving ape; and we all acquiesced in the pictures as truthful and accurate. With the progress of discovery, however, another phase of the question has come uppermost, and anthropologists have now for some time inclined with marked distinctness to the exactly opposite view. As we examined more and more closely the relics of the cave-men, for example, it became clear that their works of art were those not merely of real human beings, but of human beings considerably in advance of many existing savages. Professor Boyd Dawkins, who knows more about the cave-men than any one else in Britain at least, unhesitatingly states his opinion that they were in all important respects the equals of the modern Esquimaux, whom he indeed regards as their probable lineal representatives. Any one who has closely examined the remains recovered from the French caves can not fail largely to fall in with this view, so far at least as regards the high level of palæolithic art. In fact, it is daily becoming clear that the antiquity of man is something even deeper and more far-reaching in its implications than Lyell himself at first imagined. For while on the one hand geologists are inclining more and more to the opinion that palæolithic man was as old as or older than the last glacial period, anthropologists on the other hand are inclining more and more to the opinion that this pre-glacial and inter-glacial man was really quite as human and quite as capable of civilization as any race now living, except perhaps a few of the most cultivated European stocks. Instead of being the "missing link," our cave-man turns out to be a mere average savage, living a rude and unintelligent life, to be sure, but quite capable, so far as regards his faculties, of becoming as civilized as the Sandwich-Islanders have become within our own memory.

It is, of course, obvious that these facts may be easily turned by opponents of Darwinism into powerful arguments against the theory of man's evolution from a lower form. "Here we accept all your facts," says the defender of the fixity of species; "we allow that man has inhabited the earth for as long a period as you choose, say 200,000 years; and, when we go down to the very beginning of that period, what do we meet with? A missing link? An evolving ape? No; nothing of the sort; a man exactly the same as the man of the present day. However far back we push our researches in the past, we find either no man at all, or else the same man that we now know. Your theory of evolution is disproved by the very facts which you were wont to allege in its favor. We used at first to argue against your facts, because we did not see in what direction they really pointed: nowadays we allow them all, and we find in them the very best bulwark of our own belief."

This argument, or something very like it, has lately been employed with great effect by Dr. Mitchell, of Edinburgh, in his able and interesting work, "The Past in the Present." The Scotch archæologist there shows good grounds for supposing that the cave-men and the river-drift men were really, in faculties and potentialities, the equals of most existing savages, if not even of our own average English population. He gives excellent reasons for the belief that while we have advanced very greatly in social organization and in material comfort since that early date, we may have advanced very little, if at all, in brain-power or in potentiality of thought. There are still isolated communities in out-of-the-way parts of Scotland which use hand-made pottery of the rudest primeval type, and spin with stone whorls of the prehistoric pattern; while their works of imitative art are ruder and more unlike the originals they depict than anything ever attempted by the earliest known men. Yet these people, as Dr. Mitchell rightly observes, are fully the equals in intelligence and moral feeling of their contemporaries in the great manufacturing centers. Hence we must not confound mere material backwardness with lowness of type or intellectual deficiency. It is probable, nay, almost certain, that the ordinary cave-man was superior in ingenuity and mental power to nine out of ten among our modern savages, and quite equal to the fair run of our own laboring classes.

Nevertheless, I believe it is allowable for us frankly to admit all these facts, and yet remain evolutionists just as heartily as before. No doubt our general tendency was at first in the opposite direction, and many evolutionists will be staggered by the conclusions of Professor Dawkins and Dr. Mitchell, while others will endeavor, under the influence of false prepossessions, to dispute their facts. But modifiability of opinion is the true test of devotion to truth, and honest thinkers can hardly fail to modify their opinions on this question in accordance with the latest discoveries. After frankly and fairly facing all the difficulties of the situation, I believe we may come at last to the following conclusions, which, for clearness' sake, I will number separately: 1. The cave-men were not only true men, but men of a comparatively high type. 2. But the river-drift men, who preceded them, were men of a lower social organization, and probably of a lower physical organization as well. 3. The earliest human remains which we possess, though, on the whole, decidedly human, are yet, in some respects, of a type more brute-like than that of any existing savages. 4. They specially recall the most striking traits of the larger anthropoid apes. 5. There is no reason to suppose that these remains are those of the earliest men who inhabited the earth. 6. There is good reason for believing that before the evolution of man in his present specific type, a man-like animal, belonging to the same genus, but less highly differentiated, lived in Europe. 7. From this man-like animal the existing human species is descended. 8. Analogy would lead us to suppose that the line of descent which culminates in man first diverged from the line of descent which culminates in the gorilla and the chimpanzee, about the later Eocene or early Miocene period.

In order to give such proof of these propositions as the fragmentary evidence yet admits, it will be necessary first to clear the ground of one or two common misapprehensions. And, before all, let us get rid of that strangely unscientific and unphilosophical expression, the Stone age.

Most people who have not specially studied prehistoric archæology, and many of those who have studied it, believe that the period of human life on the earth may be divided into three principal epochs, the Iron age, the Bronze age, and the Stone age; and that the last-named epoch may be once more subdivided into the Palæolithic and the Neolithic ages. All the great archæologists know, of course, that such a division would be utterly misleading; yet, in their written works, they have often used language which has led the world generally to fall, almost without exception, into the error. The division in question can only be paralleled by a division of all human history into three periods, the age of Steam, the age of Printing, and the age of Unprinted Books; the latter being subdivided into the mediæval and the Egyptian ages. The real facts may much better be represented thus:

There are two great geological epochs in which we find remains of man. The first is that of the palæolithic or old chipped-flint weapons. The second is the modern or recent period, including the three so-called Neolithic, Bronze, and Iron ages. The first or palæolithic epoch is separated from the second or recent epoch by a vast and unknown lapse of time. We may place its date at somewhere about 200,000 years back. The remains of human origin belonging to it all occur under the conditions which we ordinarily describe as geological; they are found either in the drift deposits of our river-valleys or beneath the concreted floors of caves. They consist chiefly of rude stone weapons, in unpolished flint, chipped off by side-blows. What events caused the break in continuity between palæolithic and recent man in Europe we do not exactly know; but many of the best authorities believe that it was brought about by the coming on of the last glacial epoch (that is to say, the final cold spell of the recurrent pleistocene cycles). If these authorities are right, then at a period earlier than 200,000 years since, Europe was peopled by palæolithic men; and about 80,000 years ago these men were very gradually driven southward by the spread of the polar ice over the whole of the northern temperate zone. Be this as it may, however, we know, at any rate, that they belonged to a far earlier state of things, when the whole geographical condition of Europe differed in many respects from that which prevails at the present day.

On the other hand, recent man in Europe dates back, probably, only some twenty thousand years or so. His remains, whether of the Neolithic, the Bronze, or the Iron age, are found in tumuli still standing on the surface of the ground. Since his reappearance here, no notable changes have taken place in the face of the country. Instead of occurring in deep natural deposits or under the solid floors of primeval caves, his bones and his weapons are found in graves or mounds of recent make. The neolithic men, though they used implements of stone, polished them exquisitely by grinding and smoothing, and were in all respects, save in the use of metals and a few similar particulars, as advanced as their successors of the Bronze age. No great gap in time separates them from the bronze and iron men, as a great gap separates all three from the palæolithic cave-men and drift-men. They were probably identical with two modern races, in three successive stages of their culture; whereas, the palæolithic race is cut off utterly from the recent race by a whole unknown interval, presumably representing the time during which Northern Europe was glaciated. Accordingly, with recent man we shall have nothing to do here.

Again, I must further premise that the very question which heads this paper—who was Primitive Man?—is in itself a somewhat irrational one. For of course, if we accept the evolutionist theory at all, there never was a *first* man. The early undifferentiated ancestors of men and anthropoid apes slowly developed along different lines toward different specific forms; but there never was a point in the series at which one might definitely put down one's finger and say, "Here the man-like ape became a complete man." All that we can do is to decide that the ancestors of modern man at such and such a given date had progressed just so far in their way toward the existing highest type.

Professor Boyd Dawkins, in his recent work on "Early Man in Britain," and in his discourse at the last meeting of the British Association, has so clearly summed up the results of all the latest investigations as to palæolithic man that it will only be necessary here briefly to recapitulate the views he has enunciated. He divides the men of the Pleistocene period in Europe and Asia into two successive classes, the earlier or river-drift men, and the later or cave-men. The drift of the Thames, Somme, and other rivers is the earliest geological stratum in which we find unquestionable evidence of the existence of man. The evidence in point consists entirely of chipped flint instruments of the very rudest type, incomparably ruder than anything produced by the very lowest of modern savages. Man at that period was clearly a rough and perhaps almost solitary hunter, using rude triangular stone implements. Moreover, we have evidence of that homogeneous condition which betokens an early stage of evolution, in the fact that implements of precisely the same sort are found all over Europe, Asia, and Africa. The primæval hunter who chased the stag in Africa had brethren who chased the fallow deer in Spain and Italy, and others who chased the various wild beasts among the jungles of India. Over the whole Eastern hemisphere, so far as we can judge, man was then a single homogeneous race, living everywhere the same life, and producing everywhere the same rude and primitive weapons.

The drift-men were succeeded, in Northern Europe at least, by another and higher development of humanity, the cave-men. How far they may have differed physically from their predecessors of the Drift period we have no sufficient means of judging; but the analogy of other human varieties would lead us to suspect that they presented some marked signs of advance; for we know that among all existing races there is a pretty constant ratio between social development and physical peculiarities. At any rate, the cave-men were apparently far more advanced in the rudiments of culture than the drift-men, especially toward the end of the cave period, during which they made continuous advances in the arts of life. Their weapons, though still chipped (instead of being ground, like those of the neolithic Europeans and the modern savages), were more varied in shape and better worked than the rude triangular hatchets of the drift. They manufactured, in their last stage, excellent barbed harpoons of good designs. They made fish-hooks and needles of bone with some degree of finish. They employed ruddle for personal decoration, and collected fossil shells, which they drilled and strung as necklaces. Moreover, they had a remarkable talent for imitative art, producing spirited sketches on mammoth ivory or reindeer horn of various animals, living or extinct. In fact, they seem to have been in most essential particulars almost as advanced as the modern Esquimaux, with whom Professor Dawkins conjecturally identifies them.

But if Professor Dawkins means us to understand that the cave-men were physically developed to the same extent as the Esquimaux, it is necessary to accept his conclusion with great caution. It does not follow, because the Esquimaux are the nearest modern parallels of the cave-men, that the cave-men therefore resembled them closely in appearance. Several of the sketches of cave-men, cut by themselves on horn and bone, certainly show (it seems to me) that they were covered with hair over the whole body ; and the hunter in the antler from the Duruthy cave has a long pointed beard and high crest of hair on the poll utterly unlike the Esquimau type. The figures are also those of a slim and long-limbed race. And when Professor Dawkins tells us that the very earliest known man was unquestionably a man and not a "missing link," it becomes a matter of importance to decide exactly what the phrase "a missing link" is held to imply.

Man differs from the anthropoid apes mainly in the immensely larger development of his brain ; for the other peculiarities of his pelvis, his teeth, and the position of his head on the shoulders, are mere small adaptive points, dependent upon his upright attitude and the nature of his food. Even the lowest savage and the oldest known human skull have a brain-capacity far bigger in proportion than that of the highest apes. Now, this brain could not, of course, have been developed *per saltum ;* it must have been slowly evolved in the course of a long and special intercourse with nature. But between civilized man and his early ancestor, common to him and the anthropoid apes, there must at some time have existed every possible intermediate link. Some such links still survive in the Bushman, the Australian black fellow, and the Andaman-Islander. Other and earlier links probably became extinct at various previous periods, under the pressure of the higher varieties from time to time developed, just as these lowest savages are now in process of becoming extinct before the face of the European colonist. But we would naturally expect the men of the palæolithic period to be still a trifle more brute-like in several small particulars than any existing savages, because they were so much the nearer to the primitive common ancestor, a few of whose distinctive traits they would probably retain in a higher degree than any race now living. In short, while it would be absurd to suppose that palæolithic men were "missing links" in the sense of being exactly half-way houses between apes and Bushmen, it is yet natural to expect that they would be the last or penultimate links in a chain whose other links are many and wanting. Do we, as a matter of fact, find any such slight traces of brute-like structure in the earliest human remains which have come down to us?

In dealing with this question we have to remember in the first place that the number of quite undoubted palæolithic human bones of the earliest period is all but absolutely *nil;* and that even the few dubious and suspected bodily remains which we possess, presumably of that age, are for the most part mere broken fragments. Most of our palæolithic bones belong to the latest cave age, and represent a comparatively high race of savages, known as the Cro-Magnon men. Of their earlier predecessors we know but little. We have, however, two remarkable portions of skulls, one of which is almost free from suspicion, while the other, though more doubtful, is still accepted as genuine by good Continental anthropologists. Both apparently belong to the earliest age of the cave-men. The first is the celebrated jaw of La Naulette. This is a massive and prognathous bone, with enormous and projecting canine teeth; and these canine teeth, as Mr. Darwin notes, point back very clearly to a nearly anthropoid progenitor.* The second is the much-debated Neanderthal skull, which possesses large bosses on the forehead, strikingly suggestive of those which give the gorilla its peculiarly fierce appearance. So good an anatomist as Professor Rolleston assures us that, if these frontal sinuses had been found without the skull to which they are attached, he would have been a bold man indeed who would venture to pronounce them human. The thickness of the bones in the rest of the Neanderthal skeleton, to which Professor Schaafhausen calls attention, also approximates to the anthropoid pattern. "No other human skull," says that able anthropologist, "presents so utterly bestial a type as the Neanderthal fragment. If one cuts a female gorilla skull in the same fashion, the resemblance is truly astonishing, and we may say that the only human feature in this skull is its size." All the skulls of what De Quatrefages and Hamy call the "Canstadt race" show these same low characteristics, and "must have presented a strangely savage aspect." The other supposed relics of the earlier cave-men are either too slight, too much crushed, or too uncertain, to be of much use for purposes of argument. When we add that even the later cave-man was almost certainly hairy, like the modern Ainos, we have before us the picture of what may fairly be considered a sort of missing link, though only the last in a long chain.

Moreover, it is a most deceptive practice to speak of the cave-men as if they were a single set of people, representing a merely temporary type. As a matter of fact, the period covered by the cave remains is enormously long, and the men of one epoch must have differed widely from those of another. M. de Mortillet has actually distinguished three subdivisions of the cave period, marked by a successive improve-

* Since this article was sent to press, Professor Maska, of Neutitschein, has discovered a human jaw-bone, associated with pleistocene mammalian remains, in the Schipka cave (Moravia). This bone, which belonged to a very young child (as inferred from the development of the teeth), "is of very large, indeed, of colossal dimensions."

ment in the arts of working stone and bone, to which he gives the names of the Moustier epoch, the Solutré epoch, and the La Madelaine epoch, from the stations which best typify each stage of primitive culture. M. Broca has shown that, between the time when the Moustier cave was inhabited by troglodytes and the time when the La Madelaine cave was similarly inhabited, the valley of the Vézère had undergone a denudation to the depth of twenty-seven metres ; while from the date of the La Madelaine cave to our own time the denudation was only four or five metres. In other words, the interval between the two epochs was far greater than the interval between the last of them and our own times.

As to the drift-men, the few bones attributed to them are so singularly and suspiciously like those of neolithic times that it seems very unsafe to build any definite conclusion upon them. Accordingly, when Professor Dawkins tells us that " the river-drift man first comes before us endowed with all human attributes, and without any signs of a closer alliance with the lower animals than is presented by the savages of to-day," I think we must venture to suspend judgment for the present. Seeing that a later skull, like that of Neanderthal, is strikingly ape-like in one most important particular, is considerably lower in general type than that of the lowest living savage, and (as Professor Huxley has shown) is rather nearer the chimpanzee than the modern European in outline, it seems hazardous to conclude on very dubious evidence that a still earlier race had skulls as well formed as those of the neolithic Iberians. The least doubtful cases are acknowledged to be identical in character with the far later Cro-Magnon remains (belonging to the latest cave age), which in itself is enough to rouse considerable suspicion. So many supposed palæolithic skeletons, like the "fossil man" of Mentone, have turned out on further examination to be neolithic or later, that it is unwise to base conclusions upon them, when those conclusions clearly run counter to the general course of evolution.

With regard to the previous history of the human race, we can only guess at it by the analogy of the other higher mammalia. But late researches have all gone to show that the general progress of mammalian development has been singularly regular. If we apply this analogy, and couple it with the other known and observed facts, we may be able still further to bridge over the gap between man and his anthropoid progenitor. As Professor Huxley remarks, "The first traces of the primordial stock whence man has proceeded need no longer be sought, by those who entertain any form of the doctrine of progressive development, in the newest tertiaries ; they may be looked for in an epoch more distant from the age of the *Elephas primigenius* than that is from us."

The bifurcation of the European placental mammals begins in the Eocene ; and it is to the Eocene that we must look for the earliest appearance of the Primates. At that period, there existed lemurs in Europe and America, of a transitional type, showing points of resemblance to the hoofed animals of the same age, the ancestors of our own horses and tapirs. The Eocene was the epoch of the first great placental mammalian population, and we know that in such early epochs of each main class, when the class is assuming a dominant position, it always possesses an immense plasticity, rapidly dividing and subdividing into more and more definitely specialized types. Accordingly, it was probably as early as this period that the ancestors of the higher apes began to differentiate themselves from the ancestors of the modern lemurs. All analogy shows us that these divisions begin a long way down in time, proceed rapidly at first, and grow less rapid as the various creatures become more and more specialized, so losing their original plasticity.

In the Miocene, the specialization of the Primates must have continued very fast; for as early as the mid-Miocene strata we find in Continental Europe a large anthropoid ape, identified by good authorities as a close relation of the modern gibbons. Other apes of the same date are similarly identified as nearly allied with other living genera. Hence the question naturally arises—if the bifurcation of the Primates had already proceeded so far in the mid-Miocene period that even existing genera of higher apes had been fairly well demarkated, must not the ancestors of man have already begun to be generically distinct from the ancestors of the other anthropoids? Is it not consonant with analogy to suppose that the monkey group should have separated from the lemur group in the Eocene; that the anthropoid apes should have separated from the monkeys in the lower Miocene; and that the human genus (as distinct from the fully developed human species) should have separated from the anthropoid apes in the mid-Miocene? There seems to be good reason for this conclusion.

In mid-Miocene strata at Thenay, the Abbé Bourgeois has found certain split flints, some of them bearing traces of fire, which he believes to be of artificial origin; and in this belief he is upheld by M. de Mortillet, Dr. Hamy, MM. de Quatrefages, Worsaae, and Capellini, and other distinguished anthropologists. Specimens may be seen in the Musée de St. Germain, almost as obviously human in their workmanship as any of the St. Acheul type. M. Delaunay has similarly found a rib of an extinct manatee, which seems to have been notched or cut with a sharp instrument; and M. Ribeiro, of the Portuguese geological survey, has noted wrought flints in the Miocene deposits of the Tagus, which he exhibited in Paris in 1879. On the evidence of these and other facts M. de Mortillet pronounces in favor of what he calls Tertiary man. But as he carefully distinguishes him from Quaternary man, "l'homme de St. Acheul"—the river-drift man of Professor Dawkins—I suppose he means to imply that this species, though belonging to the same genus as ourselves, was yet so far unlike us, so little differentiated, as to be man only in the generic, not in the specific sense.

Professor Boyd Dawkins, on the other hand, argues apparently against the existence of man in any form in Miocene Europe. "There is," he says, "one important consideration which renders it highly improbable that man was then living in any part of the world. No living species of land mammal has been met with in the Miocene fauna. Man, the most highly specialized of all creatures, had no place in a fauna which is conspicuous by the absence of all the mammalia now associated with him. . . . If we accept the evidence advanced in favor of Miocene man, it is incredible that he alone of all the mammalia living in those times in Europe should not have perished, or have changed into some other form in the long lapse of ages during which many Miocene genera and all the Miocene species have become extinct." But, if I understand M. de Mortillet aright, this is just what he means by distinguishing Tertiary from Quaternary man. Professor Dawkins argues as though the animal which split the Abbé Bourgeois's flints must either have been man or not-man; but the whole analogy of evolution would lead us to suppose that it was really a "tertium quid" or half-man; as Professor Dawkins himself suggests, a creature "intermediate between man and something else," a creature which should "bear the same relation to ourselves as the Miocene apes, such as the *Mesopithecus*, bear to those now living, such as the *Semnopithecus*."

But Professor Dawkins, who seems strangely unwilling to admit the existence of such an intermediate link, endeavors to account for the split flints of the mid-Miocene by curiously round-about ways. "Is it possible," he asks, "for the flints in question, which are very different from the palæolithic implements of the caves and river deposits, to have been chipped or the bone to have been notched without the intervention of man? If we can not assert the impossibility, we can not say that these marks prove that man was living in this remote age in the earth's history. If they be artificial, then I would suggest that they were made by one of the higher apes then living in France rather than by man. As the evidence stands at present, we have no satisfactory proof either of the existence of man in the Miocene or of any creature nearer akin to him than the anthropomorphous apes. These views agree with those of Professor Gaudry, who suggests that the chipped flints and the cut rib may have been the work of the *Dryopithecus*, or the great anthropoid ape, then living in France. I am, however, not aware that any of the present apes are in the habit of making stone implements or cutting bones, although they use stones for cracking nuts." And, in a foot-note, Professor Dawkins further observes: "Even if the existing apes do not now make stone implements or cut bones, it does not follow that the extinct apes were equally ignorant, because some extinct animals are known to have been more highly organized than any living members of their class." Does not this reasoning exactly remind one of that which was current when M. Boucher de Perthes first called attention to the Abbeville flints?

Now, I confess I am at a loss to comprehend why Professor Dawkins should be so anxious to escape the natural inference that these flints were split by an ancestor of man. If he were a determined opponent of evolutionism, it would be easy enough to understand his attitude; but, as he is a consistent and bold evolutionist, one can hardly guess why he should go so far out of his way to get rid of a simple conclusion. He argues most strenuously that man was fully developed in the Pleistocene age. He can not imagine that man reached this full development by a sudden leap or miraculous interposition. And, therefore, he might naturally conclude that an early and less differentiated ancestor of man was living in the Miocene age, and developing upward through the Pliocene times, till he reached that highly specialized specific form which he had demonstrably attained in the later Pleistocene period. Implements such as we should naturally expect *a priori* to be produced by such an intermediate form are actually forthcoming in the Miocene. The traces of use and marks of fire upon them seem irresistible proofs—the edges are chipped and worn exactly like those of undoubted flake-knives—while the regular repetition of their shapes is most noticeable. Yet, for some unknown reason, rather than accept the plain conclusion of M. de Mortillet, Professor Dawkins prefers to believe that they were produced by apes, and to leave man without any traceable ancestry whatsoever. Surely he does not believe that man was suddenly evolved, at a single bound, from a creature no nearer akin to him "than the anthropomorphous apes." Yet this is certainly the conclusion which most readers would draw from his facts and arguments.

It is clear that the difficulty in all these cases depends upon the too great definiteness of our words, with their hard-and-fast lines of demarkation, when applied to the gradual and changeful forms of evolving species. The very question as to the existence and character of "primitive" man thus becomes one of mere artificial and arbitrary distinctions. We try to draw a line somewhere, and wherever we draw it we must necessarily cause confusion. Let us try, then, to set forth the probable course of evolution in the line which finally culminates in civilized man, from the Eocene age upward, using so far as possible such language as will the least involve us in classificatory distinctions.

In the very first part of the Eocene age man's ancestors were very plastic and unspecialized placental mammals of the early "generalized" type. They were still so little removed from the original form, so little adapted for special habits and habitats, that they at the same time closely resembled the progenitors of the horses and the hedgehogs.

But before the middle of the Eocene period this homogeneous group had begun to split up into main branches. And by the later Eocene times the particular branch to which man's ancestors belonged had reached, even in Europe, the stage of lemuroid creatures—four-handed and relatively small-brained animals, still retaining many traces of their connection with the ancestral horse-like and insectivore-like forms. These lemuroids were forestine, and, perhaps, nocturnal fruit-eaters. They lived among trees, which their hands were especially adapted for climbing.

In the lower Miocene times the lemuroids again must have split up into two main branches, that of the monkeys and of the lemurs. We find no trace of the monkeys in the remains of this age; but, as they were highly developed in the succeeding mid-Miocene period, they must have begun to be distinctly separated at least as early as this point of time. To the monkey branch, of course, the progenitors of man belonged.

By the epoch of the mid-Miocene deposits the monkey tribe had once more presumably subdivided itself into two or three minor groups, one of which was that of the anthropoid apes, while another was that of the supposed man-like animal who manufactured the earliest known split flints. The anthropoid apes remained true to the old semi-arboreal habits of the race, and retained their four hands. The man-like animal apparently took to the low-lying and open plains, perhaps hid in caves, and, though probably still in part frugivorous, eked out his livelihood by hunting. We may not unjustifiably picture him to ourselves as a tall and hairy creature, more or less erect, but with a slouching gait, black-faced and whiskered, with prominent prognathous muzzle, and large pointed canine teeth, those of each jaw fitting into an interspace in the opposite row. These teeth, as Mr. Darwin suggests, were used in the combats of the males. His forehead was no doubt low and retreating, with bony bosses underlying the shaggy eyebrows, which gave him a fierce expression, something like that of the gorilla. But already, in all likelihood, he had learned to walk habitually erect, and had begun to develop a human pelvis, as well as to carry his head more straight upon his shoulders. That some such an animal must then have existed seems to me an inevitable corollary from the general principles of evolution, and a natural inference from the analogy of other living genera. Moreover, we actually find rude works of art which occupy a position just midway between the undressed stone nut-cracker of the ape and the chipped weapons of palæolithic times. This creature, then, if he existed at all, was the real primitive man, and to apply that term to the cave-men or the drift-men is almost as absurd as to apply it to the civilized neolithic herdsmen.

The supposed Miocene ancestor of humanity must have been acquainted with the use of fire, and have been sufficiently intelligent to split rude flakes of flint. But his brain was no doubt about half-way between that of the anthropoid apes and that of the Neanderthal skull. Such an intermediate stage must have been passed through at some time or other, and the mid-Miocene is just about the time when one would naturally expect it to have existed. The fact that no bones of this man-like creature have yet been found militates very little against the argument, for in all cases the mammalian remains, which we actually possess from any particular stratum, are a mere tithe of the species which we know must have been living during the period when it was deposited. And, after all, the works of man (or of a man-like animal) are just as good evidence of his existence as his bones would be; for, as Sir John Lubbock rightly observes, the question is whether men then existed, not whether they had bones or not.

During the Pliocene period, the scent does not lie so well, and we seem to lose sight for a while of man's ancestry. Such gaps are common in the geological history, and need surprise no one, considering the necessarily fragmentary nature of the record, based as it is upon a few stray bones or bits of flint which may happen to escape destruction, and be afterward brought to light. Some cut bones, however, have actually been detected in Tuscan Pliocenes, and may possibly bear investigation. Professor Dawkins, it is true, objects that the presence of a piece of rude pottery together with the bones casts much doubt upon their authenticity. But Professor Capellini, their discoverer, now writes that Mr. Dawkins is mistaken in this particular, and that the pottery belongs to quite a different stratum from the bones. Other marked remains have been discovered in Pliocene strata elsewhere; and worked flints have been detected in the gravels of St. Prèst, which, however, are of doubtfully Pliocene age. Nevertheless, the ancestors of man must have gone on acquiring all the distinctive human features during this period, and especially gaining increased volume of brain. If we could find entire skeletons of our Miocene and Pliocene progenitors, analogy leads us to suppose that naturalists would arrange them as at least two, if not more, separate species of the genus Homo. Whether we should call them men or not is a mere matter of nomenclature; but that such links in the chain of evolution must then have existed seems to me indisputable.

In the Pleistocene period, we come at last upon undoubted traces of the existing specific man. The early Pleistocene strata show us no very certain evidence; but in the mid-Pleistocene we find the earliest indubitable flint flake, split by chipping, and very different in type from the workmanship of the supposed mid-Miocene man-like creature. In the later Pleistocene we get the well-known drift implements. Without fully accepting Professor Dawkins's argument that the drift-men were human beings of quite a modern type, one may at least admit that the remains prove them to have been really men of the actual species now living—men not much further removed from us than the Andamanese or the Digger Indians. Accordingly, we can not suppose that they had been developed straightway from a totally inferior quadrumanous form, and reached their Pleistocene mental eminence by a leap. "The implements of the drift," says Professor Dawkins, "though they imply that their possessors were savages like the native Australians, show a considerable advance on the simple flake left behind as the only trace of man of the mid-Pleistocene age." They also show a still greater advance upon the very rude chips of the unknown mid-Miocene ancestor. Hence the progressive improvement is exactly what we should expect it to be, and we are justified, I think, in concluding that by the beginning of the Pleistocene age the evolving anthropoid had reached a point in his development where he might fairly be considered as a man and a brother. At the beginning of that age, he was probably what naturalists would recognize as specifically identical with existing man, but of a very low variety. By the mid-Pleistocene he had become an ordinary savage of an exaggerated sort, and by the age of the drift he had reached the stage of making himself moderately shapely stone implements. The river-drift man, however, as Professor Dawkins believes, has no modern direct representative—or, to put it more correctly, the whole race, even in its lowest varieties, has now quite outstripped him, certainly in culture, and probably in *physique* as well.

At last, we reach the age of the cave-men. By that period, man had become to a certain extent cultured. He had learned how to make finished implements of stone and bone, and to draw and carve with spirit and with a rude imitative accuracy. It is possible enough that the cave-man was the direct ancestor of the Esquimaux, and that that race has kept its early culture with but few later additions and improvements.* Nevertheless, it does not at all follow that in physical appearance the earlier cave-men were the equals of the Esquimaux, or, indeed, that the Esquimaux are any more nearly related to them than ourselves. They may have been darker-skinned and less highly human looking; they probably had lower foreheads, with high bosses, like the Neanderthal skull, and big canine teeth like the Naulette jaw. Even if the Esquimaux are lineally descended from the later cave-men with little change of habit or increase of culture, the mere lapse of time, aided by disuse of parts, may have done much to modify and mollify these brute-like traits. "The fact that ancient races," says Mr. Darwin, "in this and several other cases" [he is speaking of the inter-condyloid foramen, observed in so large a proportion of early

* I am not, however, inclined to attach much importance to the evidence of Esquimau art; or rather, that art seems to me to point in the opposite direction. After carefully comparing numerous specimens, I am convinced that the art of the cave-men is of quite a different type from that of the Esquimaux, and far higher in kind. Both, it is true, represent animals; but there the likeness stops. The Esquimaux represent them with wooden stiffness; the cave-men represent them with surprising spirit and life-like accuracy.

skeletons], "more frequently present structures which resemble those of the lower animals than do the modern races, is interesting. One chief cause seems to be that ancient races stand somewhat nearer than modern races in the long line of descent to their remote animal-like progenitors." We must not be led away by identifications of race in too absolute a sense. We ourselves are, of course, the lineal descendants either of the cave-men or of their contemporaries in some geologically unexplored region ; yet it does not follow on that account that our late Pleistocene ancestors were white-skinned people with regular Aryan features. Granting that the Esquimaux are nearer representatives of the cave-men than any other existing race (which is by no means certain), it may yet be true that the earlier cave-men themselves were black-skinned, hairy savages, with skulls and brains of the low and brutal Neanderthal pattern. The physical indications certainly go to show that they were most like the Australian savages.

With the cave-men our inquiry ceases. The next inhabitants of Europe were the comparatively modern and civilized neolithic Euskarians—a race whom we may literally describe as historical. I trust, however, that I have succeeded in pointing out the main fallacy which, as it seems to me, underlies so much of our current reasoning on "primitive man." This fallacy lies in the tacit assumption that man is a single modern species, not a tertiary genus with only one species surviving. The more we examine the structure of man and of the anthropoid apes, the more does it become clear that the differences between them are merely those of a genus or family, rather than distinctive of a separate order, or even a separate sub-order. But I suppose nobody would claim that they were merely specific ; in other words, it is pretty generally acknowledged that the divergence between man and the anthropoids is greater than can be accounted for by the immediate descent of the living form from a common ancestor in the last preceding geological age. Mr. Darwin even ranks man as a separate family or sub-family. Therefore, according to all analogy, there must have been a man-like animal, or a series of man-like animals, in later, if not in earlier tertiary times ; and this animal or these animals would in a systematic classification be grouped as species of the same genus with man. In the Abbé Bourgeois's mid-Miocene split flints we seem to have evidence of such an early human species ; and I can conceive no reason why evolutionists should hesitate to accept the natural conclusion. To speak of palæolithic man himself—a hunter, a fisherman, a manufacturer of polished bone needles and beautiful barbed harpoons, a carver of ivory, a designer of better sketches than many among ourselves can draw—as "primitive," is clearly absurd. A long line of previous evolution must have led up to him by slow degrees. And the earliest trace of that line, in its distinctively human generic modification, we seem to get in the very simple flint implements and notched bones of Thenay and Pouancé.—*Fortnightly Review.*

LIFE AMONG THE BATTAS OF SUMATRA.

By Dr. A. SCHREIBER.*

ALTHOUGH the Battas have a writing and a very limited literature, it has never occurred to any one among them to compile and preserve their historical traditions. Consequently their history, as we know it, reaches back for only a short distance in time, and gives no clew by the aid of which we can learn when and whence they came to Sumatra. They are not able to trace their origin to any greater distance than the highlands of Toba, where the greater part of their people now dwell. The tradition of their derivation from Toba prevails, so far as I know, among all of their tribes, on every side of the highlands. We are not well enough acquainted with the interior of Northern Sumatra to be able to state how far they may have pressed toward the southwest; but they are found in the south to the equator and on the west and east in single spots to points immediately on the sea. They seem to have conquered their settlements in the southern districts a considerable time ago, and to have subjected or destroyed the Malayan aborigines.

We will go into a Batta town early in the morning. The night-mists have not yet disappeared from the woods around, but we already hear a bustle, as we are approaching the edge of the village, of women pounding rice. The rice, which is the principal food of the people, is always kept in the hull, and is thrashed out day by day as it is needed. The thrashing is done with hard-wood pestles eight or ten feet long in wooden mortars made from a stump or a log. It is hard work, yet the women are frequently accustomed to perform it with their babies strapped to their backs, where the infant is exposed to all the abrupt and awkward oscillations of the mother's head. The rice must be carefully cleaned after it is thrashed, for the lord of the house will not be trifled with, and, if he finds a husk in his breakfast, it may turn out a bad day for the woman.

The town is composed of a street about fifty feet wide, with a row of respectable-looking houses, all built on piles, on either side. We are, in fact, in a land of pile-houses, and nothing more than a glance around is needed to convince the visitor of the fallacy of the notion that all the pile-houses were built in lakes. The Batta houses are some eight or ten feet high, frequently set up on still higher poles. The poles are not very large, but are made of wood selected for its lasting qualities, and often of heart-wood. They are planted in the ground in rows, and so connected by cross-bars that, shake as much as it may in time of storm or earthquake, the house will not fall

* Abridged from articles in "Das Ausland."

down. The house is reached by stairs which are connected in some cases with the gable-front, in others with a trap-door in the middle of the floor. The buildings are of two distinct types. The dwelling-houses proper consist of a tightly inclosed story, having a few small windows, and covered with an overhanging roof, the high gables of which permit the garret-space to be left open for the free circulation of the outer air. Another class of houses, which are evidently pavilions of luxury and indicate wealth, are built on larger posts than the others, and have no inclosure whatever. They have a fire-place in the middle of the floor, seats and lounges, and perhaps a balustrade around the edge. The roof-space is separated from the rest by a flooring and used as a granary. The lower open story of these *sopos* serves for a variety of uses. Strangers and guests coming to the town are received in them ; the men sit in them mornings and evenings, chatting and smoking ; justice is administered and public business transacted in them ; they are occupied during the day by women weaving ; and at night strangers, widowers, and unmarried young men sleep in them.

The Batta does not make his morning toilet in the house, but at the special bathing-places, or *pantjurs*, with which every village is provided. These places are arranged at a running stream or a canal made for the purpose, by fixing a water-pipe of bamboo in such a manner that a man standing or sitting under it can have the water run all over his body. Such baths are taken morning and evening. Separate *pantjurs* are provided for the women. It is one of the morning duties of the women and girls, even down to children of four and five years old, to bring drinking-water in the *gargitis*, a water-vessel made of a thick stalk of bamboo. The size and strength of growing girls are generally measured by the number of *gargitis* they can carry.

Let us follow a woman into one of the inclosed dwelling-houses. The floor is made of round bamboo beams about as large as one's arm, across which are laid split bamboos far enough apart to let the water and dirt through, and make sweeping unnecessary. Broad, raised seats and lounges, covered with mats of various patterns and styles, are arranged on either side. In the corners are fire-places of a primeval simplicity, flat, square boxes filled with earth, and upon these some thick stones, between which the fire burns quite briskly, while the rice is cooked in home-made earthen vessels set upon them. The number of families living in the house can generally be calculated from the number of fire-places to be seen. No division is made in the day-time between the parts of the house occupied by the different families, but a separation is made between the sleeping-places at night by hanging up mats. Ordinarily, only blood relations live together in the same house. The children of both sexes, after they have grown up, sleep outside of the house and not with their parents, the young men in the *sopos*, the girls in parties of several with some old widow ; but the children, till they have households of their own, take their meals with their parents. At meals the whole family sit around the rice-pots. They formerly used leaves for plates, but they now generally have European plates. As a rule, they eat immediately from the hand, which is previously washed in a vessel of water kept ready for the purpose. The nice point in eating consists in not allowing the finger-tips to touch the lips, but in letting the rice drop from the fingers into the hollow of the hand just before it is given to the mouth.

The Batta men do not always begin their day with breakfast. In the busy season of rice-culture they often have a couple of hours' work to do in the rice-field. If the man is wealthy enough to have a buffalo, he has to drive him all around and over the field between the rows, so as to destroy the weeds by treading them down into the soft mud. It is most convenient to do this early in the morning, as the buffaloes are driven from the yard to the pasture. If the man has no buffalo, he has to dig at the weeds laboriously with his hoe. The buffalo is the principal domestic animal of the Battas, and is kept chiefly for treading out the rice-fields. The value of the animal is regulated by the length of his horns, and this is measured by comparison of the length of his owner's arm from the forefinger. If the horns are long enough to reach to the arm-pits on the other side, the animal corresponds with the Batta equivalent for "thorough-bred."

The sugar-palm affords the common drink of the people, which they call *tunak*, and of which a single tree, if properly taken care of, will furnish a considerable daily supply for months at a time. Flavored and made stronger by the addition of bitter roots, it is greatly enjoyed by the many, though despised by a few, and may be indulged in to a considerable excess without making drunk. It has become a burning question, among those who have been converted to Mohammedanism, whether the drinking of *tunak* is allowable under their law, and the favorite beverage may yet become the occasion of a religious schism.

The Battas attribute all serious sickness to the work of evil spirits, *begu;* and, as they know by experience that persons who go down from the highlands and remain for a considerable length of time on the coast or in the flat country are liable to be attacked by a virulent fever after their return, they have come to consider the *begu* of the sea, the *begu laut*, a particularly malignant and dangerous spirit.

A woman who had been visiting her relatives in the flat country was attacked and brought low with one of these fevers. Her husband did not hesitate long, for she was a valuable help and had cost half his estate in purchase-fees, but sent immediately for the most famous *datu*, or medicine-man, in the region. An honorarium regulated by the value at which the wife was held was paid the doctor, and an equal sum was promised him in case of recovery. Incantations and external means were tried for a few days with no beneficial results, and then the doctor decided that he must make a *parsili:* this was a figure of the sick person, of about her size, cut out of the soft stem of a banana-tree, and clothed with a few rags. It is dedicated to the particular object it is designed to serve, with a certain set of magic forms, and is laid in the road outside of the town, with the expectation that the wicked spirit will come out of the sick person and go into it. As another means of making sure that this should happen, the sick woman was "stolen," or secretly taken in the night to another house. When all this proved to be of no avail, the medicine-man declared that he had an extremely perverse spirit to deal with, and must use the most energetic means to drive it out. He pounded up a double handful of the terribly sharp red and green Spanish peppers, and sprinkled the juice into the mouth, nose, eyes, and ears of the poor sick woman, in order to bring the spirit to terms by means of the fearful pain the operation excited. When this did not help, the medicine-man lost confidence, notwithstanding a hen was sacrificed in his honor every day, and would not stay any longer. He did not say so, however, but went off secretly; for he foresaw that he would inevitably suffer great shame and reproach if the patient should die on his hands. Of course—for that is understood there—he would have to go away empty-handed if the case proved fatal.

An expedient sometimes resorted to in desperate cases is to consult the *begu* itself for advice. For this purpose all the sick person's family connections living in the town, men, women, and children, assemble at the house. The room having been cleared for the occasion, is dimly illuminated by means of torches made by rolling up a leaf and pouring melted pitch into it. The spectators take their places in a circle around the room, while the actors in the drama are seated in the middle. On one side are the musicians, two, four, six, or eight young fellows, armed with drums of bamboo and deer-skin, and cymbals and gongs, bought from the Chinese, which are kept with the greatest care, in cases specially made for them, among the most precious heirlooms of the family. Of course no melody can be brought out from such instruments, but the musical effect produced by them consists in a variety of rhythms, some of which are quite complicated and characteristic. Opposite the orchestra sit two men, one of whom is the *sibaro* or *haroem ni begu*, or medium. Among the Battas who are still heathen, each family or each town has two of these mediums, generally a man and a woman. No one devotes himself to the office of medium of his own free-will, and it requires the learning of no art; but, when the *sibaro* dies or goes away, the *begu* itself chooses a new one by taking possession of him; and, waiting this, the *obligato* music is kept up in the presence of the whole family till the desired event takes place. The *sibaro* is dressed in his ceremonial robes; from his head hangs a strip of cloth reaching to the floor, under which is a vessel of burning incense, the smoke of which rises to his head. After the music has sounded for a short time, the body of the *sibaro* begins to tremble. He throws off the cloth and rises, and begins, with outstretched arm and a fixed look at the distance, slowly to turn to the rhythm of the music. At the same time a time-keeping convulsion, beginning in his fingers, extends from limb to limb, finally engaging the whole body, till at last the man dances in spasmodic leaps, which continue till he collapses in exhaustion. The music now ceases, and the time has come for the head of the family to question the *begu* which has taken possession of the medium, first asking its name. The *begu*, having given its name, then asks why it has been called; and in response to this overture the whole occasion of the trouble is related, and the spirit's good advice is requested. The most important question is, whether there is any hope of the recovery of the patient, and what must be done to secure that desirable result. If the family are not satisfied, as they are not likely to be with the unfavorable answer that is generally given, the music and the dancing are repeated, or the process is applied to the second *sibaro*. It sometimes happens that the two mediums do not agree in their revelations, and then the drumming and the dancing and the questioning are kept up till they are of accord. If the final answer is that there is no hope for the sick man, he is left to his fate, which has most probably been made more certain by his having had to endure the prolonged torture of witnessing these ceremonies; if a more favorable answer is given, all that the spirit requires as a condition of recovery is performed in good faith.

If the ceremonies are interrupted by the death of the patient during their performance, the music ceases and lamentations take its place; the company go away, leaving only the nearest relatives of the deceased at the house; a few shots are fired, either to drive away evil spirits, or to give notice of the death, and preparations are begun for the funeral.

The existence of cannibalism among the Battas and some peculiarities connected with it suggest some questions respecting its origin. The principal question is whether it is a survival from the original barbarism of the people, or is an offense of later beginning. All the evidence I have met in my investigations points to the latter conclusion as more probable. Among the evidences is the fact that the practice occurs, not among the more degraded tribes, but among those which are most distinguished from their neighbors by intelligence and culture. Other facts, favoring the same view, are: 1. The Battas have traditions of a primitive time when man-eating was unknown among them. They say that it originated during a long civil war, in the course of which the hostility of the opposite factions became so embittered that they went to the extremity of eating captured enemies. 2. Cannibalism is unknown among other people evidently related to the Battas—the inhabitants of the Island of Nias, for instance, whose language is nearly the same, and who are of a lower degree of civilization. 3. The fact that cannibalism is practiced, not to satisfy hunger or gratify the taste, but only in cases regulated by law.

Accepting the theory of a comparatively modern origin of cannibalism, the question still remains, of the immediate occasion of its introduction. Aside from the tradition already mentioned, we can imagine but three grounds on which it could have been based. Human flesh may have been first eaten under stress of necessity, and found so palatable that the practice was continued; superstition may have suggested the idea that the eating of the flesh would secure the eater against the bad influence of the spirit of the eaten one; or, the ignominious extirpation of an offender may have been considered a good method of showing the general abhorrence of him. This last view, advocated by Marsden, seems to me most improbable, for it is unthinkable that cannibalism could have come to prevail in this way among a people who had not previously known it. The second view, that of a superstitious origin, appears more probable; and it is no real objection to it that the Battas now do not know anything of such superstition, for there are many other customs of which the people who practice them can not give a satisfactory account. The former view seems, however, still more probable, for it is most reconcilable with psychological laws, and agrees with the traditions.

The region within which cannibalism prevails has been considerably contracted within the last three years, in consequence of the extension of Dutch authority over Silindung and Toba; for man-eating is, of course, extinguished wherever Dutch influence prevails. The heathenism of the Battas is, moreover, fast declining before the persistent attacks of Christianity; and Mohammedanism, with its most repulsive traits, must also pass away.

SKETCH OF CHARLES ADOLPHE WURTZ.

CHARLES ADOLPHE WURTZ, President of the French Academy of Sciences, is one of the recognized leaders of modern chemistry. Much of his work is regarded as of the first importance in connection with chemical theory, and he is justly considered one of the chief pioneers of modern organic chemistry.

Professor Wurtz was born in Strasburg, November 26, 1817, and was taught in his earlier studies at the Protestant Gymnasium in that city. He afterward studied in the Medical Faculty of Strasburg, where he was chief of the chemical department from 1839 to 1844, and received his degree in 1843. He began his chemical career as an assistant to Dumas. Having come to Paris, he was made preparateur to the course of organic chemistry of the Faculty in 1845. He afterward filled the position of chief of the chemical department in the School of Arts and Manufactures from 1846 to 1851, and was made a fellow in 1846. He gained his first independent position in 1851, as professor in the Agricultural Institute at Versailles. After the death of Orfila, in 1853, and the retirement of Dumas, in 1854, the chairs which they had filled were united in the chair of Medical Chemistry, and Professor Wurtz was made its occupant. In 1866 he became Dean of the Medical Faculty, and gained much credit as such by his firm and moderate course during the troubles with the students in 1867 and 1868, when the best professors in the faculty were denounced to the Senate. He resigned this office in April, 1875, and was appointed, in the following August, Professor of Organic Chemistry in the Faculty of Sciences. He has also been a member of the hygienic committee, a member and secretary of the Chemical Society, and a member of the Philomathic Society.

The chemical researches of Professor Wurtz have been numerous, original, and important. The Royal Society's catalogue contains a list of seventy-three titles to papers which were published by him previous to 1864. The publication of his investigations was begun in 1842, with a paper on the constitution of the hypophosphites. This was followed by researches on phosphorous acid, sulpho-phosphoric acid, etc., which greatly added to our knowledge of the phosphorus compounds. It was during his experiments on the hypophosphites that he discovered the hydride of copper, a substance which derives interest from its own peculiarities, as well as on account of the rarity of metallic hydrides. Professor Wurtz's next researches were directed to the cyanic and cyanuric ethers, and brought forth, among other results, the discovery, in 1849, of the so-called compound ammonias formed by the displacement of one of the atoms of hydrogen in ammonia, by organic radicals like methyl and ethyl. A third important investigation, published in 1855, resulted in the confirmation of the theory of Laurent, Gerhardt, and Hoffmann, of the double nature of the alcohol radicals—that the substances obtained from alcohol as radicals were not the simple radicals, but were compounds of those radicals with themselves. This has afforded one of the strongest arguments in favor of the view now generally entertained by chemists, that free hydrogen is a compound of hydrogen with hydrogen. Other investigations, which must enter into the summing up of the work of Professor Wurtz in this line, are those on the glycols, and on ethylene oxide ; on the action of nascent hydrogen on aldehyde ; on the action of chlorine on aldehyde ; on the action of hydrochloric acid on aldehyde ; on the synthesis of neurine ; and on abnormal vapor densities.

In 1864 he was awarded, at the instance of the Academy of Sciences, the Emperor's biennial prize of twenty thousand francs. Two years afterward, or in 1867, he was elected a member of the Academy, in the chemical section, in place of M. Pelouzet. In 1878 he received the Faraday medal from the English Royal Society, and was elected a member of the Bavarian Academy of Sciences.

Professor Wurtz presided at the meeting of the French Association for the Progress of Science which was held at Lille in 1874, and delivered the opening address, on the subject of the "Theory of Atoms in the General Conception of the Universe." In this address he revealed a catholicity of spirit, including all men of every nation and creed, and every branch of science, in a community of interest and privilege in the advancement of knowledge, and a poetic capacity of temperament, to which his dry chemical researches gave few opportunities of expression. After sketching Bacon's plan, or dream, for the universal exploration of the earth and the cosmic forces, he said: "Two centuries and a half ago the conception of Bacon was regarded as a noble Utopia; to-day it is a reality. That magnificent programme which he then drew out is ours, gentlemen; ours not in the narrow sense of the word, for I extend this programme to all who, in modern times and in all countries, give themselves to the search for truth, to all workers in science, humble or great, obscure or famous, who form in reality in all parts of the globe, and without distinction of nationality, that vast association which was the dream of Francis Bacon. Yes, science is now a neutral field, a commonwealth, placed in a serene region, far above the political arena, inaccessible, I wish I could say, to the strifes of parties; in a word, this property is the patrimony of humanity." Having reviewed the recent progress in the sciences of chemistry, physics, and physical astronomy, and spoken of the kinetic theory, he added that these sciences "teach us that the worlds which people infinite space are made like our own system, and the great universe is all movement, co-ordinated movement. But, new and marvelous fact, this harmony of the celestial spheres of which Pythagoras spoke, and which a modern poet has celebrated in immortal verse, is met with in the world of the infinitely little. There, also, all is co-ordinated movement, and these atoms, whose accumulation forms matter, have never any repose; a grain of dust is full of innumerable multitudes of material unities, each of which is agitated by movements. All vibrates in the little world, and this universal restlessness of matter, this 'atomic music,' to continue the metaphor of the ancient philosopher, is like the harmony of worlds; and is it not true that the imagination is equally bewildered and the spirit equally troubled by the spectacle of the illimitable immensity of the universe, and by the consideration of the millions of atoms which people a drop of water?" The address concluded with the words: "Such is the order of nature; and, as Science penetrates it further, she brings to light both the simplicity of the means set at work and the infinite variety of the results. Thus, through the corner of the veil we have been permitted to raise, she enables us to see both the harmony and the profundity of the plan of the universe. Then we enter on another domain which the human spirit will be always impelled to enter and explore. It is thus, and you can not change it. It is in vain that Science has revealed to it the structure of the world and the order of all the phenomena; it wishes to mount higher, and in the conviction that things have not in themselves their own reason for existing, their support, and their origin, it is led to subject them to a first cause—unique, universal God."

In 1878 Professor Wurtz delivered the Faraday Lecture of the English Chemical Society, taking for his subject "The Constitution of Matter in the Gaseous State." In this lecture he gave a clear exposition of the kinetic theory of gases, which postulates them as "composed of small particles moving freely in space with immense velocities, and capable of communicating their motion by collision or friction," and suggested that it had "shed a sudden clearness, an unexpected light, on matters which seemed to be veiled in the deepest obscurity," and added that the labors by which this theory had been worked out "mark a resting-place in our course, and are, perhaps, an approach toward the eternal problem of the constitution of matter—a problem which dates from the earliest ages of civilization, and, though discussed by all the great thinkers of ancient as well as of modern times, still remains unsolved. May we not hope that in our own time this problem has been more clearly stated and more earnestly attacked, and that the labors of the nineteenth century have advanced the human mind in these arduous paths more than those of a Lucretius, and even of a Descartes and a Newton? From this point of view the discoveries of modern chemistry, so well expressed and summarized by the immortal conception of Dalton, will mark an epoch in the progress of the human mind."

In the same year Professor Wurtz, having been charged by the French Minister of Public Instruction to make inquiry into the organization of the laboratories and the practical instruction given in the several universities of Germany and Austro-Hungary, made a number of journeys to the great seats of learning in those countries. In his report he insisted strongly on the danger of creating large establishments, where students are taught something of everything, and on the necessity of creating special foci for every large section of experimental science. He showed the advantage of special institutes, and insisted upon the organization of chemical, physical, physiological, anatomical, and pathological institutions, such as flourish on the other side of the Rhine.

A second report on this series of observations has been published within the present year. It contains descriptions of the great scientific establishments of Berlin, Buda-Pest, Gratz, Leipsic, and Munich, and is confined to a simple account of what the author observed in the institutions described; for, he says, "an unmeasured and uncritical approbation in such a matter would be equally misplaced. . . . Everything has been said upon the importance of high scientific training, one of the treasures of the human mind. A great country should increase it continually, in order to be able to diffuse it abundantly."

Besides the multitude of papers embodying the results of his special investigations, and his addresses, Professor Wurtz is the author of a number of works of a more general character, among which are his "Traité élémentaire de Chimie médicale" (Elementary Treatise on Medical Chemistry), 3 vols., Paris, 1864–'65; "Leçons élémentaires de Chimie moderne" (Elementary Lessons of Modern Chemistry), 1866–'68; "Dictionnaire de Chimie pure et appliquée" (Dictionary of Pure and Applied Chemistry), 1868 and following years, with an introduction published separately in 1868, under the title "Histoire des Doctrines chimiques" (History of Chemical Doctrines); "Les hautes Études pratiques dans les Universités Allemandes" (High Practical Studies in the German Universities); and an unfinished "Treatise on Biological Chemistry" (vol. i, 1880). The "Dictionary" just mentioned, which was completed in 1879, after twelve years of preparation and publication in numbers, is pronounced by the "Revue Scientifique" the most complete treatise on chemistry now existing in France. In its preparation, Professor Wurtz was assisted by his fellow-chemists and compatriots, who contributed special articles, each working in the line to which he had given the most attention. Professor Wurtz himself furnished the theoretical articles, especially those having reference to the theory of atoms and their unitary grouping in compounds, of which he is the leading expositor. "In these articles," says the "Revue Scientifique," "the reader will recognize the vigor and precision of style which are the stamp of the works of M. Wurtz." In English translations have been published "Chemical Philosophy according to Modern Theories" (London, 1867), and "Theory from the Age of Lavoisier" (1869). His two latest works, in their English translations, have gained considerable circulation in the United States. The "Elements of Modern Chemistry" (1880) is a text-book, the leading features of which are defined by a discriminating critic in "Nature" to be "clearness of statement, selection of typical facts from among the vast array at the service of the chemical compiler, and devotion of a comparatively large space to chemical theory, and to generalizations which are usually dismissed in a few words in the ordinary text-book"; withal, notwithstanding its copiousness, the book "is exceedingly interesting and eminently readable." The "Academy," reviewing the same work, speaks of its author as "universally recognized as one of the most able of living chemists; he is also an exact thinker, deeply imbued with philosophical ideas, and a very successful teacher." The book comprises a complete introduction to both inorganic and organic chemistry, and presents the newest ideas regarding such subjects as atomicity and isomerism. The other book, "The Atomic Theory," is one of the "International Scientific Series," and fits in well with what is perhaps the most important work of the author's life ; for it records the development and present position of a doctrine which he has had as large a part as, if not a larger part than, any other man in bringing to the shape in which it is now generally received by chemists. It embraces an historical introduction, containing a concise, accurate, and complete history of the theory of atoms from the times of the Greek philosophers and Lucretius, and from the revival of the doctrine by Dalton to the present time. A second part includes a full exposition of the theory as it is now held and applied. It is described, by the critic in "Nature" from whom we have quoted, as "at once a scientific treatise and an artistic work, . . . marked with a distinct individuality and self-completeness," and as conveying a sharp impression, "without making any great sacrifice of accuracy."

All of Professor Wurtz's later works are characterized by the marks of his strong faith in his own conception of the atomic theory, and for this he has been criticised—perhaps by some one whose theory is a little different—as too much inclined to treat theoretical considerations as identical with facts, and as, seemingly, supposing facts to be explained when they are only stated in the language of his theory. He has himself given an illustration of the manner in which this may be brought about, by explaining in his Faraday lecture that, whenever we attempt to make well-observed facts and their immediate consequences—the only certain things in the physical sciences—the basis of any general theory, "hypothetical data are apt to mix themselves up with our deductions."

Professor Wurtz has been President of the Academy of Sciences in Paris since 1881. His merits have been recognized by the French Government by the bestowal of the decoration of the Legion of Honor in 1850 and by promotion to the rank of officer in 1863, and to that of commander on the occasion of his acting as a member of the French section of the International Jury at the Great Exhibition in London, in 1869. In July, 1881, he was appointed a Senator for life in the French Senate, by a large majority, and became the third member of the Academy of Sciences who was in the enjoyment of a seat in that body, his two scientific colleagues being M. Robin and M. Dupuy de Lome.

CORRESPONDENCE.

THEORY OF THE SUN'S LIGHT AND HEAT.

Messrs. Editors.

IN the June number of "The Popular Science Monthly," a new theory of the origin of the light and heat of the sun is attributed to Dr. H. R. Rogers, of Dunkirk, New York. An able and succinct statement of the theory was given by Dr. Rogers, in a paper read before the American Association for the Advancement of Science, in Cincinnati, August, 1881. But many persons had already become acquainted with this electric theory, through a work in which it is fully and clearly stated, entitled "Light, Heat, and Gravitation," published in 1879, two years before the reading of Dr. Rogers's paper. This work was written by Hon. Zachariah Allen, a well-known scientist and distinguished citizen of Providence, Rhode Island. Mr. Allen's new cosmical theory was the result of a long period of devoted study and experiment, but, though known to intimate friends, it was not given to the world till about three years ago. H. P. R.

PROVIDENCE, R. I., *June* 23, 1882.

ORIGIN OF STORMS.

Messrs. Editors.

WHILE out on the prairies of Dakota this summer I have observed certain peculiar storms which may throw some light on the origin of storms. The birth of a storm, as a writer in "The Popular Science Monthly" some time since declared, is a matter upon which we have as yet no accepted theory.

About a month since I observed late in the afternoon a thunder-storm moving northeast, the rain of which barely touched the part of the country where I was. As this edge of the storm was passing over, there came an undercurrent of scudding clouds from the northeast. These two currents coming in conflict, there formed over and near us rings and funnels. A large ring of clouds would rotate for some minutes, send down a funnel, perhaps, and then disappear, forming a cigar-shaped cloud. One large ring, no doubt more than a half a mile in diameter, had the appearance of an inverted crown, jagged clouds extending from it earthward; and another looked like a turbine water-wheel. Through the whirlwinds darted vivid lightning, followed by peculiarly loud and ominous thunder. The lightning seem confined to the clouds. In about twenty minutes the whirlwind passed over, and the heavy thunder-storm traveled rapidly to the northeast.

About a week since I saw almost similar phenomena. A storm, apparently quite light, was coming from the northwest, and a light breeze was blowing from the opposite quarter. Scud soon came from the southeast, and, the winds coming in conflict, whirlwinds appeared, resulting in cigar-shaped clouds that rolled off to the southeast. The rain was very heavy, but there was little thunder or lightning.

While on the south coast of Lake Superior two summers ago, I saw a storm gather which presented similar features. Like the two preceding cases it occurred late in the afternoon of a rather warm day. There formed a great ring of heavy cumuli which extended around the whole heavens 20° or 30° from the horizon, and after rotating for some minutes the cumuli were heaped together in the south quarter of the sky, and the thunder-storm passed south.

From these instances I infer that some storms have their origin in conflicting currents of air. Clouds form because of the difference of temperature, and first assume the form of rotating rings, sometimes with funnels attached. These rings part, and form themselves into rolling, cigar-shaped clouds, which ultimately become ordinary nimbi. Very truly, H. STANLEY.

FORESTBURG, DAKOTA, *August* 5, 1882.

CENTRAL AMERICAN GEOGRAPHICAL NAMES.

Messrs. Editors.

I DO not know whether it has ever before been noticed, but, if not, I should like to call the attention of scholars interested in the subject to the noticeable repetition, in Central American geographical names, of one of the principal (the accented) syllables in the word "Atlantic," if we may divide it thus: A-tlan-tic.

Some of these Central American names are—Minatitlan, Hidalgo-titlan, Abasolotitlan, Morelotitlan, Barragantitlan, Allende-titlan. There are, doubtless, a great many more.

Without some proof to the contrary, this coincidence would seem to add a little weight to the belief that Central America was the fabled (?) A-tlan-tis.

Yours respectfully, BERRY BENSON.

AUGUSTA, GEORGIA, *August* 29, 1882.

EDITOR'S TABLE.

MALLOCK AND HIS NEW SCIENCE.

MR. WILLIAM HURRELL MALLOCK, having settled to his own eminent satisfaction the little preliminary question, "Is Life worth Living?" has now taken another step in his intellectual career. And this new step is, if possible, more ambitious than the preceding, for he informs us that he is the discoverer of a new science. He has lately issued a little book entitled "Social Equality; a Short Study in a Missing Science,"* in which he professes to have come upon the mainspring of human progress, and to have found the very tap-root of all civilization. These are simply *the desire for inequality*, which Mr. Mallock declares to be an essential and universal element of human nature. This is, no doubt, a considerable thing to have accomplished, but it is not Mr. Mallock's special discovery: what he claims is to have discovered the "Science of Human Character," while his philosophy of inequality is but a deduction from it. The "New York Evening Post," discussing Mr. Mallock's book in a prominent article, makes light of his pretensions, and closes by saying, "The whole argument is really a juggle with words, and his discovery of the science of human character a monstrous mare's nest." We are inclined very much to agree with this verdict, and to regard Mr. Mallock's book, considered as a contribution to thought, as not worth reading.

But it will be asked, Why, then, notice it? The reply is, that a man, though he may be of little account as a philosopher, may yet have significance as a phenomenon; and that a book, though essentially worthless, may still be influential and mischievous. Mr. Mallock discourses freely, boldly, and ingeniously on social science, and the public to which he appeals is but very imperfectly instructed upon that subject. And not only so, but it happens that just now there is no little ferment in regard to social questions, while so much that is crude, shallow, and ridiculous is passed off under the name, that doctrines, no matter how absurd, if emanating from a prominent author, are sure to get attention and find acceptance. Mr. Mallock is, moreover, a lively and agreeable writer, and this is so great a merit as, with many, to excuse any amount of speculative nonsense. That a jaunty and garish *litterateur* should announce himself as a great revealer of new scientific truth would seem on the face of it to be an excellent joke, but nothing facetious is here intended. We do not propose to analyze Mr. Mallock's book, nor to answer his arguments, but only to characterize the performance, and extract from it its unintended lesson.

Of the author's claim to have discovered a new science, we have simply to say that its impudence is only equaled by its stupidity. Mr. Mallock evidently neither knows what science is, nor has he the faintest idea of the conditions of its origin and development. There can be little doubt that he is profoundly ignorant of even its rudiments, and has probably never made a solitary original observation, if even attempt at observation, in any of the sciences, although encompassed by their phenomena from childhood. He certainly can know nothing of the difficulty of scientific research, the amount of labor it involves, or the mental discipline demanded for its successful pursuit, even in the elementary stages of its investigation. He seems to be ob-

* G. P. Putnam's Sons. Pp. 212. Price, $1.25.

livions of everything relating to the history of the growth of scientific ideas, their slow and gradual evolution by the labors of many devoted students, the successive introduction of new conceptions, and the increasing complexity of scientific problems, as the human and social sphere of phenomena is approached. And yet, with an effrontery unparalleled even in this brassy age, Mr. Mallock announces that he has discovered—not merely a new fact or a new principle, which would alone be sufficient to satisfy the aspiration of many a life-long devotee of research, but that he has discovered, and offers to the intellectual world, a whole new science, and that the most exalted of all, the "Science of Human Character."

In entering the field of social study Mr. Mallock finds, indeed, that others have been there before him, although he alleges that they have all missed the great science which it has been his good fortune to discover. Mr. Herbert Spencer is the most prominent thinker of our time on questions of sociology, or the scientific exposition of man's social relations, and to him, therefore, our author gives his chief critical attention. He declares that Mr. Spencer has missed, or does not recognize, or does not know that science of human character which is at the basis of the science of social relations. He says (page 92):

> Surely, one might think nothing could be more clear than this. The science described thus must not only, like Buckle's, point to a science of character, but it can be nothing more or less than the science of character itself. Such would be naturally our conclusion from the extracts above quoted; but, if we follow Mr. Spencer further, we shall see that it would be a wholly wrong one. The science of character he does indeed touch upon; but he does this as though he hardly knew what he was doing. Though he touches it, he does not grasp it; though he sees it, he does not recognize it. Never wholly out of contact with it, he is yet always sliding off it, as though it were an inclined surface. Not once does he fasten on it, as the real center of the question.

These declarations are nothing less than amazing. They evince the completest ignorance of the true character of all Mr. Spencer's work. That which distinguishes it and marks him off from every other thinker in the field is the comprehensive thoroughness of his preparation for working out the principles of social science. He published a very original treatise upon the subject in 1850, which was far in advance of the time, but he quickly found that it was inadequate, and would require a far broader preparation than hitherto attempted to place it upon a secure and sufficient foundation. The task proposed was the establishment of general principles of sociology, or the laws of the origin, organization, and constitution of human societies. The whole field was surveyed, the work laid out, and its execution entered upon. A cyclopædia of social facts was projected, descriptive of the phenomena of all orders of human societies, stationary and progressive, from the lowest to the highest grades. This is simply a vast contribution to the science of human nature, by displaying, on the largest scale, the varied phenomena of social activity, or how different kinds of men have behaved in their social relations.

Character is the sum of the qualities which distinguish one thing from another; human character is the assemblage of traits that distinguish man as man from other living creatures, and the different kinds of men from each other. These qualities that constitute human nature consist of two groups, bodily and mental; and the study of human character involves the analysis of man's corporeal and psychical nature so as to arrive at the general truths in each department. The science of human nature is, therefore, nothing less or more than the working out of the laws of man's physical and mental constitution.

The units of human society are human beings, and the character of the aggregate must inevitably depend upon the character of the constituent units. A biological and psychological analysis of the human being was therefore an essential preliminary to the study of man in his social relations. Mr. Spencer took up this problem in its widest aspect in his "Principles of Biology" and his "Principles of Psychology," to each of which he devotes two elaborate volumes. In these comprehensive works the whole series of problems in human nature, which are preliminary to the science of society, is exhaustively treated; so that these works are nothing more nor less than broad systematic contributions to the science of human character.

More than this, the new point of view assumed in all of Spencer's philosophic books had explicit reference to the true understanding of the constitution of human nature. The law of evolution, as postulated and developed in "First Principles," and carried out in the subsequent works, gave a new interpretation of the nature of man. He is there considered in his total character as a product of slow-working natural agencies, internal and external, by which he has been developed and modified so as to become adapted to a progressive social state. This great law was worked out as a key to the right understanding of human character, and in subordination to a development of a true science of human society. Thus, in the logical line of his inquiry, each essential step in the elucidation of the law of evolution, the exposition of the laws of life and the laws of mind, had a definite and positive bearing upon social problems, simply by extending and giving greater method and validity to the science of human character.

But, although Spencer has contributed in this extensive way toward the establishment of the principles of human nature, physical and mental, which form the science of character, yet he is the last man to make any pretense to the *discovery* of such a science. Only an ignoramus devoured with egotism could put forth the preposterous claim that he had made the discovery of a science which is in reality but the summation of the scientific labors of multitudes of men in many successive ages.

LITERARY NOTICES.

Ideological Etymology; or, a New Method in the Study of Words. By Stephen Pearl Andrews.

Elements of Universology: An Introduction to the Study of Philosophy and the Sciences. With Special Reference to the Science of Music. By Stephen Pearl Andrews. New York: S. P. Lathrop & Co.

The first of these little works was noticed by us when it first came out as a paper read before the American Philological Association at its Newport meeting. It purports to be a demonstration that there is a new and heretofore untried method in glottological study, and that the meanings of all the several hundred root-words of the Indo-European family of languages are reducible to no more than three mother ideas. These views are a part of that extensive system of thought which Mr. Andrews has been engaged for many years in elaborating. He claims to have originated and developed a universal science—a science of the sciences—to which, as is generally known, he gives the name of "Universology." Having taken up this point of view, and arrived, as he maintains, at that which is both universal and fundamental in science, Mr. Andrews then proceeded to make this the basis of a new language, equally scientific and universal, which he names "Alwato." The claim is put forth by the adherents of Mr. Andrews—Universologists and Alwatoists, as they avow themselves—that there is a wonderful originality and an immeasurable importance in this new system; and they hold that its immensity alone has repelled investigation and hindered the progress of the new ideas and discoveries. But they insist that, in the claims which have been made, no exaggeration has occurred, and that we have really in these works of Mr. Andrews nothing less than "the culmination of philosophy in its intimate and precise alliance with all the special sciences, and with every phase and form of human life, individual and collective."

No doubt the reason thus given why this philosophy has made its way so slowly has truth in it, as large and extensively ramified and complex conceptions can not be grasped and mastered except through corresponding effort. But there is probably another reason which has also been operative in hindering the study of "Universology." Mr. Andrews is an erudite philologist and a man of great mental independence. As a consequence he uses his vast lingual resources with a freedom that borders upon license. Rules are lightly regarded—he makes his own rules; and, being an irrepressible inventor, he coins new words as easily as he breathes. These qualities are of course necessary to the constructor of a new and universal language; but the practical effect has been that even his English expositions of universological doctrine have been so inlaid and overlaid with new, technical, and, according to accepted standards, outlandish terms, that they have frightened off readers and been a powerful hindrance to the students of his system. A universal science and a universal language, coming all at once and from the same party, have favored both discouragement in their acquisition and a grave suspicion as to the genuine quality of so vast an undertaking. And this doubt has been unquestionably much re-enforced by the general acceptance in recent years of evolutionary ideas, which imply slow growth through long periods, by small increments of change, in the mental as well as in the material world. These considerations, even if indecisive and illegitimate, may help to explain the reluctance, if not the prejudice, with which Mr. Andrews's system has been received.

But, aside from the enormous friction of the lingual medium employed, a system of universal science is at best hard to reproduce in a newspaper article. Mr. Andrews's radical idea is that of similarity or parallelism of method or of analogy among the sciences. He maintains that this is their most fundamental relation, and that it forms itself a distinctive and all-comprehensive science. The analogy of individual life to the collective life of society, propounded by Plato, expounded by Hobbes, and worked up into the modern doctrine of "the social organism," may be taken as an example of analogy among the sciences. But in this case all the phenomena are of a common kind, and fall within the single category of biological science. An example of remoter analogy is furnished where we compare organic with inorganic sciences. In his celebrated discourse on geological reform, given in his "Lay Sermons," Professor Huxley develops this idea very clearly in tracing out the analogy between our knowledge of the living creature, biological knowledge, and our knowledge of the constitution of the globe, or earth-knowledge, as he terms it. He brings both these phenomenal spheres under the large conception of "Evolutionism," and points out the structural, functional, and developmental similarities that are traceable between them. Assuming the validity of this idea, Mr. Andrews proceeds to carry it out systematically, and to bring all departments of knowledge into unity on the analogical basis. His work is done with great learning and great ingenuity. He has served a long apprenticeship at finding analogies, and he sees them everywhere. Not only are the sciences as now advanced correlated by innumerable traces of cousinship, but all the past stages of science are filiated by the same ties—his net brings in everything. Not only physics, chemistry, biology, mathematics, astronomy, geology, but metaphysics, ontology, philology, archæology, history, and all the stages of inquiry are enmeshed in a grand analogical unity. The old doctrine of fire, air, earth, and water, though now to the scientific mind only representing a crude stage of thought, altogether erroneous but useful in an age of ignorance, is installed in Mr. Andrews's exposition, as may also be the total product of the mind of man in all the stages of its growing intelligence.

The real question, of course, is as to the value of this immense work, and to what extent it has been pushed into the sphere of mere fancy. To what degree is it legitimate science? It is not to be denied that the history of scientific ideas is full of the examples of futile effort in tracing out fanciful relations in nature and holding them to be truths of nature. The growth of true science has been little else than an historic fight of the human mind against its tendency to substitute its own cheap and frivolous imaginations for verifiable facts and demonstrative truths. Theology for thousands of years interpreted nature by such superficial conceptions of the relations of its parts as could be arrived at without serious investigation or any real knowledge. For thousands of years the explanations of nature were deduced from the properties of words, and modern science only arose through a protracted struggle with this tendency. It is but recently that the connection between succeeding forms of life, which paleontology reveals as a great fact in the history of the earth, was held to be but an ideal relation as taught by theology; while the recent progress of biological science has consisted in substituting for it a genetic relation, or an actual dynamic causation. Science, therefore, must be regarded as most strictly occupied with its proper work in establishing the actual causal and determining relations among phenomena. So far as analogy can be made a help in arriving at such positive and substantial results, its function is legitimate for scientific purposes; but, pressed further, it will probably continue to be regarded as an impediment to fruitful investigation.

But Mr. Andrews is a courageous and independent thinker, who wants no instruction from us as to the value or importance of the work he is doing. He claims to be already the center and master of a group of disciples which form a normal school of preparation for larger operations in the way of propagating his ideas. We are, moreover, informed that "a university for the elaboration and diffusion of the new science (Universology) has for several years been chartered under the general act of Congress for the District of Columbia, and is only waiting more ample endowment to take on large and imposing proportions." Certainly plenty of work is cut out for such a university. A part of its programme is "one language for the whole world," the "future vernacular of the planet." This might seem to be a vast gain (assuming incidentally its practicability), as we should hope that such a language would supersede the multitudinous tongues that are now such a burden in education. But the hope is vain; Mr. Andrews says that "Alwato so facilitates the acquisition of all other languages that the prior existing languages will be kept living, and the valuable literatures of the world retained and their acquisition made easy. . . . English, French, German, etc., will survive for their special literatures and localities. . . . So greatly is the scientific method superior to the crude natural spontaneity which merely lets matters drift 'at their own sweet will.'" Nevertheless, this spontaneous drift of things in which Mr. Andrews has so little confidence, inasmuch as it has given us all the sciences and arts, and created civilization, and brought the primitive man through the route of development up to his present status of intelligence and cultivation, ought not, we think, to be too lightly discarded in behalf of a university at Washington, although chartered and even endowed by the American Congress.

Vice Versa; or, a Lesson to Fathers. By F. Anstey. D. Appleton & Co. Pp. 349. Price, $1.

We have here a most humorous novel with a very original plot. It is vigorously and vividly written, and has a great deal of naturalness in its descriptive and narrative parts, while it is pervaded throughout by a most fantastic and egregious absurdity. After the first shock, however, the reader accepts the ridiculous situation, and enjoys the wit and fun with no little curiosity to know what the author will make of his whimsical fancy. The odd conceit upon which the story hinges is the exchange of personalities between a father and son; that is, they are mutually transformed in bodily aspect, the father into the son and the son into the father, while their minds are not affected. The lad becomes outwardly the dignified London merchant, though still retaining all his boyish ideas; while the old merchant is shrunk into the school-boy and with the thoughts and feelings of an old man is packed off to the hated school, where his son had been before. The old gentleman's misadventures in his new and extraordinary situation in the school, and the boy's tantrums in charge of the old merchant's residence and business, are related with much ingenuity and irrepressible humor. The father at school and finding out how he likes it is, however, the main figure, and the book at once takes rank as a first-class satire on English boarding-school life.

The Coming Democracy. By G. Harwood, Author of "Disestablishment." Macmillan & Co. Pp. 390. Price,

We have not been able to get interested in this volume. It seems to be written from the high Tory and the High Church point of view, and professes to consider the growing tendency of modern democracy in relation to English institutions. The author first takes up democracy in relation to foreign politics, and then in relation to home politics, in which he considers its relation to the crown, the House of Lords, the House of Commons, the upper classes, the middle classes, and the lower classes. Perhaps the English may find some utility in the discussion, but we can not share their discernment.

The Change of Life, in Health and Disease. A Clinical Treatise on the Diseases of the Ganglionic Nervous System incidental to Women at the Change of Life. By Edward John Tilt, M. D., Past President of the Obstetrical Society of London. Philadelphia: P. Blakiston, Son & Co. Pp. 184.

An important work on a subject that is too little understood and is not treated with anything like adequate thoroughness in ordinary medical works. It treats the subject intelligently and intelligibly in its various aspects, beginning with the physiology and general pathology of the change of life, and discussing afterward the special pathology under the several heads of "diseases of the ganglionic nervous system," "diseases of the brain," "neuralgic affections," "diseases of the reproductive organs," "diseases of the gastro-intestinal organs," "diseases of the skin," and "other diseases."

The Cornell University Register, 1881–'82. Ithaca, New York. Pp. 120.

The university was attended during the year by 384 students. In the science departments, the collection of apparatus for physics has been increased by the expenditure of about $15,000; a new, spacious, and thoroughly equipped building for the departments of chemistry and physics has been begun, and will be ready for occupation about January, 1883; large and important additions have been made to the lithological collections; and the organization of a party of students for geological and paleontological exploration during the summer vacation was contemplated. Special attention is invited to the conditions on which the State scholarships, 128 in number, are granted, and the construction, generally favorable to the candidate, which the authorities of the university put upon them. The right, especially, of every person who is qualified, to enter the examination for the scholarships, and to have it held, is insisted upon.

Light: A Course of Experimental Optics chiefly with the Lantern. By Lewis Wright. Macmillan & Co. Pp. 367. Price, $2.

The purpose of this volume, as declared by the author, is to make a very full and vivid presentation of the body of experimental facts upon which the principles of the science of optics are based. Avowedly following Professor Tyndall, the author adopts the experimental method of teaching, and maintains that projection upon a screen, with the use of a common lantern, is far superior in general effect to any other method of demonstration, besides having the advantage of exhibiting the phenomena to a whole class or to a large audience at the same time. But while the magnificent apparatus of the Royal Institution, by which Professor Tyndall has carried lantern demonstration to an extent and perfection never before attained, is far too costly for general use, the author maintains that the greater number of experiments can be shown satisfactorily to at least a science class with only a good gas-burner, while a satisfactory lantern can be made at small expense, and is a very efficient piece of apparatus. Though the work is based throughout upon experiment, which implies that the student should become familiar with actual optical effects, yet it is very profusely and elegantly illustrated, and the numerous colored plates will be held to go far in the way of replacing the actual luminous effects. The writer offers the following prefatory observations in regard to some points of his work:

In regard to the experiments described, there are two things to be said. It would have been desirable, if possible, to have stated the originator of every experiment; but it was not possible. Attempt has been made to indicate, as far as known, the first to employ any striking very *recent* experiment; but many of great beauty seem now such common property that it is difficult to ascertain who first made them, or first adapted them for projection. I strongly suspect that we owe to Professor Tyndall many more than it has been possible categorically to ascribe to him; and am the more anxious to state this, because his just claims in higher matters appear to me almost studiously ignored by certain Continental physicists. Some arrangements are, to the best of my belief, original; but none are put forth as such except one or two expressly stated, and it should be perfectly understood that no personal claim is implied regarding any other experiments because no credit is given to some one else; the absence of such credit is simply due to sheer ignorance and the difficulty of acquiring knowledge concerning such matters.

The other remark is, that the order of the experiments differs considerably in some cases from that usually adopted. All that can be said upon that point is, that such is the result of considerable reflection, and in the belief that the order chosen is, upon the whole, best adapted to the primary end of assisting vivid conception of the physical realities considered and *the relation of the phenomena to one another*. Also, while no attempt is made to arrange the experiments in set "lectures," the order followed is believed to lend itself best to such a connected course of experimental lectures as a teacher would desire to give to his class, extended or abridged as the case may require. I am not without hope that, in such an extended course of experiments as are here collected for his choice, some hard-worked teacher may find real help in this respect. The same may be said as to the brief references made to the connection between the phenomena of light and the problems of molecular physics. Brief as they are, it is hoped they may in some minds excite a real interest in those problems, and deepen that sense of the *reality* of the phenomena which is so desirable.

Memoir of Daniel Macmillan. By Thomas Hughes, Q. C. Macmillan & Co. Pp. 308. Price, $1.50.

Mr. Daniel Macmillan, founder and head of the distinguished publishing house of Macmillan & Co., was a man of mark, of strong character, rare business talents, a man of ideas, a deeply religious man, who yet got free of the trammels of theology, and a life-long victim of pulmonary disease, which ended his life at the age of forty-four. There is much that is interesting in his biography, which is largely made up of his correspondence, and which has been admirably edited by the accomplished author of "Tom Brown's School-days." The book is interesting chiefly as a personal delineation with no ambitious effort to point a moral, and for this reason it will be chiefly prized by the numerous friends and acquaintances of the publisher, many of whom were much attached to him. There are, however, many reminiscences of books and authors in the volume, that will be appreciated by the lovers of literature.

Progressive Religious and Social Poems. By Rev. George Vaughan, of Virginia. Pp. 143. Price, cloth, $1; leather, $2. To be had from the author at Rutherford Park, New Jersey.

The author of this book, who had devoted himself with might and main to the great unselfish work of human progress in Virginia, was burned out there, and, as he alleges, much persecuted by the bigotry of that benighted community. So he has produced this volume of poems, and gets such living as he can by the sale of it. Regarding the book, Mr. Whittier wrote to the author (1877): "I have to thank thee for thy note with the inclosed poems. Their humanitarian tone is excellent." Mr. Longfellow (1880) said: "I have read the poems with interest, and coincide with Mr. Whittier in his opinion of their merits." In the presence of such authorities it would be equally presuming and superfluous for us to express an opinion; but, as far as we are competent to judge, we agree with the illustrious New England poets in their estimate of this performance.

Water-Power of the Southern Atlantic Water-Shed of the United States. By George F. Swain, S. B. Washington: Government Printing-Office. Pp. 164.

This is a part of a series of reports made in connection with the work of the Census Bureau, concerning the water-powers of the whole United States, and relates to the rivers entering the Atlantic Ocean south of James River. Reviewing the observations he has made and described, the author concludes, at the end of his work, that, leaving out of consideration the Eastern, or navigable, district, the topography of the region is very favorable for power. The rivers have steep declivities, and often cataracts or rapids of considerable magnitude. The superior wooded condition of the country and the deep, pervious soil tend to make the flow of the streams constant, though it is, perhaps, more variable than that of the streams of New England and the northern part of the Middle States. The Southern streams, however, enjoy a greater rain-fall than the Northern ones. The beds of the streams are everywhere favorable for the foundation of dams, and the banks are generally suitable for the construction of canals and buildings at the points where the water-powers occur. The chief advantage in the water-powers in the South lies in their freedom from ice. On the whole, the author believes that he is justified in asserting, from a purely technical point of view, that the advantages for the utilization of water-power in the Southern Atlantic States "are, in many respects, as good as could be desired."

Studies in Science and Religion. By G. Frederick Wright, author of the "Logic of Christian Evidences." Andover: Warren F. Draper. Pp. 390.

Though written from an orthodox point of view, and strictly "A Companion to the Logic of Christian Evidences," this is a very fair book, liberal in its views, agreeable in its tone, and instructive in its treatment. It is dedicated to Professor Asa Gray, with a pleasant reference to his "Discussions of Natural Theology," which are well known to be "Darwinian" in character, and the volume might perhaps have been more appropriately entitled "Studies in Darwinism." At any rate, it is throughout mainly a discussion of the group of topics that are at present prominently associated with Darwin's name. The author does not avow himself to be a Darwinian, and hardly goes further than to demand that the new theories of development shall be treated in future with more candor and consideration than they have hitherto received. He aims to state the Darwinian arguments with justice, and he draws upon a wide and critical reading of its adverse literature for the most effective arguments upon the other side. We regard his book as chiefly valuable for the fullness and variety of its quotations bearing upon the general subject.

But it seems to us that the antagonist arguments brought forward acquire a factitious force from the author's mode of representing them, although we do not accuse him in this of intentional unfairness. But he nevertheless commits the grave error of identifying "Darwinism" with evolution, and, by bringing forward all that has been objected to the principle of "natural selection," the accumulated illustrations of difficulties, and Mr. Darwin's own retreat from the claims he made at first, a case is seemingly made out against evolution, which appears, to say the least, very embarrassing. But it can not be too often reiterated in these times that Darwinism is *not* evolution, and that to assume them as the same thing can only lead to confusion and mischievous error. There can be no greater mistake than to suppose that the proofs of evolution are in any large sense dependent upon the proofs of natural selection, or that any restriction of the range and operation of this principle involves the validity of the evolutionary theory. Mr. Darwin has never attempted either the broad investigation or the comprehensive discussion of the law of evolution; and, by confining himself mainly to the consideration of "Darwinism," Mr. Wright virtually evades the larger problem, and to that degree his book is an inadequate representation of the present relations of science and religion.

Theologian as he is, he refers with disparagement to the *a priori* method by admonishing the reader to "note carefully the character of Mr. Darwin's reasoning as distinguished from the multitude of *a priori* evolutionists who have espoused his cause." Perhaps the author would object to the *a priori* use of mathematics in its application to physics or of any principles inductively established to the interpretation of phenomena; but, however that may be, he offers a very lame pretext for not dealing with the subject of evolution as an elaborated system of facts and principles of various orders and multifarious proofs as it now stands before the scientific mind of the age. But we cordially commend Mr. Wright's book as a well-intentioned and helpful contribution, in good temper, to some of the most interesting problems of the time.

Physiognomy: A Practical and Scientific Treatise. By Mary Olmstead Stanton, San Francisco. Printed for the Author: San Francisco News Company. Pp. 351. Price, $3.00.

The author counts herself among the disciples of Spencer and Haeckel. Many scientific men have already accepted the idea that the brain is not the sole and exclusive mental organ; but that the nervous ganglia and plexuses of human and animal organisms may also exhibit or assist in the production of mental manifestations. The author goes beyond this, and expresses the belief that "it has been reserved for a woman, however, to carry their observations and research to a finality," and that she has been able to extend and make still more comprehensive the location of mental faculties, and to prove "that the viscera also are instrumental in exhibiting mental phenomena." The signs of character in the face are reviewed in their various aspects, and the treatment of the subject is continued in chapters on the "Origin and Evolution of the Organs," "Signs of Health and Disease in the Physiognomy," "Hygiene," and "Heredity."

Statistics of the Population of the United States by States, Counties, and Minor Civil Divisions. Compiled, from the Returns of the Tenth Census, by Francis A. Walker. Washington: Government Printing-Office. Pp. lxxxix–375. With numerous Plates.

This is one of the most interesting of the many volumes of the census reports. It presents in intelligible groupings, made more plain by graphic aids, all the diversified classes of facts which are brought to light in the final summing up of the reports of the census. First, the progress of the nation, from 1790 to 1880, is reviewed by decades; then are given the facts bearing upon the settled area in 1880; statistics of cities, and urban population; the determination and position of the center of population; the elements of the population, as classified by sex, race, and native or foreign birth; and the influence of physical features (topography, temperature, rain-fall, latitude, and longitude) on population. Under these heads are presented the conclusions arrived at, with minute explanations of the reasoning and processes by which the conclusions have been reached; and the statements are supplemented by tables giving the detailed figures of statistics on which the processes and conclusions are based.

The Wave-Lengths of some of the Principal Fraunhofer Lines of the Solar Spectrum. By T. C. Mendenhall, Ph. D., Professor of Experimental Physics in Tokio Daigaku. Tokio, Japan: Published by the University. Pp. 27.

The University of Tokio having received from the makers, early in 1880, an excellent and powerful spectrometer and some superior diffraction gratings, measurements of the wave-lengths were made during the unusually clear weather of November and December. The results, which show a fairly close agreement with those of Angstrom's measurements, do not require a particular notice, except in so far as the work illustrates the extent to which the most remote lines of Western scientific investigation are observed and followed up in the distant empire of Japan.

Report upon Experiments and Investigations to develop a System of Submarine Mines for defending the Harbors of the United States. By Lieutenant Colonel Henry L. Abbott, Corps of Engineers. Washington: Government Printing-Office. Pp. 444, with Twenty-seven Plates.

The author of this report was associated with the Board of Engineers for Fortifications, in May, 1869, for the purpose of investigating and experimenting on the subject to which the report relates. The results of the experiments were embodied in a manual for the use of the Engineer troops in their practical duties as submarine miners, which was completed in 1877, and forms the basis of instruction at the School of Submarine Mining at Willet's Point. The present report embodies a full account of the general researches undertaken in the investigations, including the unsuccessful experiments, which naturally did not fall within the scope of the text-book. Among the principles on which the researches bear, are the laws governing the transmission of the shock of an explosion through the fluid; the relative merits of different explosives; and the resistance to be expected from the best class of wooden hulls. Results are given in reference to sub-aqueous explosions, electrical fuses, and modes of ignition. These facts determined, "the problem how to blow up a ship-of-war," says the author, "would then admit of the definite discussion usually applied to works of practical engineering."

Chronological List of Auroras observed from 1870 to 1879. Compiled by First-Lieutenant A. W. Greeley, U. S. A., Acting Signal-Officer and Assistant. Washington: Government Printing-Office. Pp. 76.

The list has been compiled, with a few exceptions, from the meteorological reports made to the chief signal-officer of the army. The arrangement is by States and Territories, the names of which appear in special type, as well as by dates, so that the general geographical limits of auroras at any date can be readily ascertained, while the names of particular stations are likewise easily found under their respective State heads. The descriptions by Sir George Nares of displays witnessed by the English Arctic Expedition of 1875-'76 at Floeberg Beach are also included.

Statistics of Public Indebtedness. Embracing the Funded and Unfunded Debts of the United States and the Several States, and of Counties, Cities, Towns, Townships, and School Districts. Compiled under the Direction of Robert P. Porter. Washington: Government Printing-Office. Pp. 667.

This report, a part of the series of census reports, comprises: 1. An introduction, in which is given a brief history of the growth of the national debts of the principal nations of the world, and tables are presented showing the growth and distribution of State and local indebtedness in the United States. 2. An historical and statistical account of the national debt. 3. A statement of the ownership and distribution, by States and geographical sections, of the registered and coupon United States bonds, and of the amounts of each species held abroad. 4. A history of the debts of the several States from 1790 to the present time. 5. A consideration of the power of the State Legislatures, and of county and city authorities, to contract debts binding on the State, county, or municipality. 6. An exhibit and an analysis of the bonded and floating debts and sinking funds of all cities and towns of the United States having a population of 7,500 and upward. 7. An exhibit, by States and minor civil divisions, all of which are separately presented, of the State and local indebtedness of the United States. 8. An analysis, by geographical sections and States, of the entire bonded State and local indebtedness of the country.

Appalachia, June, 1882. Boston: Appalachian Mountain Club. Pp. 97. Price, 50 cents.

The present number of "Appalachia" contains the President's annual address and the annual reports of the club. The work of the association is still directed chiefly to the White Mountains, but not to the exclusion of other ranges, and is almost sure to become more catholic in its character as the membership of the society increases and becomes diffused over other mountainous regions. Explorations have been made about Moosehead and the Rangeley Lakes; the valley of the East Branch and the New Zealand Notch, in the White Mountains, have been traversed; Bear Mountain and Passaconaway, two comparatively unknown summits, have been examined; and the Great Gulf in Mount Washington has been traversed and made accessible by the completion of a path through it. The route from the snow-field of Tuckerman's Ravine to the summit of Mount Washington has been distinctly marked, and several other interesting works have been accomplished or improved. Paths over the Twin Mountains, and a bracing up of the rocks forming the "Old Man of the Mountain," so as to prevent the destruction of the profile by their disintegration, are in view. A monograph, with sectional maps, of "the Little Mountains east of the Catskills," and a contour map of the Presidential range, are published in the present number of this journal.

Atlantis: The Antediluvian World. By Ignatius Donnelly. Illustrated. New York: Harper & Brothers. Pp. 490.

Mr. Donnelly, who writes with an enthusiasm which only an unquestioning faith in his theory can beget, undertakes to establish in this book—

That there once existed in the Atlantic Ocean, opposite the mouth of the Mediterranean Sea, a large island, which was the remnant of an Atlantic Continent, and known to the ancients as Atlantis; that Plato's description of such an island was not fable, but veritable history; that it was the region where man first rose to civilization, and became a populous and mighty nation, whence settlements were made, all around the Mediterranean, and in Western Europe and Africa, in the regions of the Baltic, Black, and Caspian Seas, and in parts of America; that it was the true Antediluvian world, the seat of the gods, and the happy lands, under whatever name the ancients of different nations called them; that the gods and goddesses of the ancient Greek and other nations were the kings, queens, and heroes of ancient Atlantis, and that the acts attributed to them in mythology are confused recollections of historical events; that the Peruvian and ancient Egyptian mythologies represented an original Atlantean sun-worship; that Egypt and Egyptian civilization were derived directly from Atlantis; that the implements of the "Bronze age" were also derived thence, and iron was first used there; that the Phœnician alphabet, the parent of all the European alphabets, and the Maya alphabet of Mexico, were derived from there; that this island was the original seat of the Aryan and Semitic families of nations, and possibly also of the Turanians; and that the nation perished in a convulsion by which the whole island was sunk into the ocean with most of its inhabitants, but that a few escaped in ships or on rafts, and spread the news through the world, whence the flood legends of the various nations.

A semi-historical support is claimed for the principal feature of this theory in Plato's record of what the Egyptian priests are said to have told Solon of Atlantis and its destruction, and in corroborative incidents in other ancient literature. The possibility of such a catastrophe as the destruction of the island is affirmed upon geological evidence. The deep-sea surveys have furnished evidence of the existence of an immense elevation in the bottom of the Atlantic Ocean, the contour and profile of which are in harmony with the descriptions of the ancient Atlantis. Some peculiarities of the flora and fauna of the two continents which have puzzled naturalists could be easily accounted for if the existence of an intermediate continent as an original center of distribution could be predicated. The flood-legends of all nations are quoted and examined by Mr. Donnelly, and shown to be reconcilable with this theory, and through it with each other. Numerous remarkable features of community in the civilizations of the Old World and the New—seeming evidences of former intercourse between the two continents, which seem to be constantly increasing—and many now hard problems in anthropology would no longer be difficult to account for, but would appear quite natural if we were allowed to suppose that men have radiated in all directions from a primary home in Atlantis. Numerous legends in the mythologies of Eastern and Western nations, curiously like each other in some features, seem to point to such a place. The Book of Genesis is found by Mr. Donnelly to be a fairly good history of Atlantis. The origin of bronze has been an impenetrable mystery. In the nature of things, copper, and perhaps tin, must have been first used separately; yet no evidence of the use of either has ever been found, except of copper in the neighborhood of Lake Superior, where implements of that metal and the marks of ancient workings of the mines have been found. Mr. Donnelly postulates as a solution of the mystery, that the Atlanteans invented bronze and introduced it into other parts of the world, and that they may have been acquainted with Lake Superior copper. Hundreds of coincidences are traced between features of the monuments, traditions, and customs of the ancient Eastern nations and of the ancient Americans, and are referred to Atlantis for explanation. Mr. Donnelly gives especial attention to lingual and alphabetic analogies, and devotes a whole chapter to tracing resemblances between the Maya alphabet, as recorded by Bishop Landa, and the Phœnician alphabet; and he suggests analogies between American and Old-World word-roots. No branch of speculation is more seductive than this, and none more easily misleading. The authenticity of the Landa alphabet has been questioned by Dr. Valentini; but Dr. Le Plongeon is represented as claiming that he has demonstrated it, and has discovered affinities between the Maya and the ancient Egyptian and the Aryan languages. His testimony thus comes in aid of Mr. Donnelly's conclusions. It is in place to remark here, also, that at least four papers read at the late meeting of the American Association—those of Dr. Phené on "Affinities between America and other Continents," of Dr. Haliburton on "Atlas and the Atlantis," of Mr. Hale on the "Origin of the Indians," and of Professor De Hass on "Geological Testimony to the Antiquity of Man in America"—embody views parallel with some of the arguments in this book. Mr. Donnelly is sometimes carried away by his enthusiasm, and leaves his readers in danger of being carried away with him. No thought of looking at the other side, or of critical examination, is apparent. The work is a kind of lawyer's brief, on which the reader may ask to be excused from making up his mind till the other side has been heard and the court has delivered its charge. It brings forward a strong array of circumstantial evidence of the possible former existence of the Atlantean Continent, and of the origin of mankind and civilization from it, against which, so far as we know, no positive evidence is offered by history or science. The theory would explain a thousand things which are not explained and seem otherwise inexplicable, and would not make a single problem more difficult. But its verification, we fear, must await the realization of Jules Verne's vision, which enabled the travelers in the fancied submarine ship to reach and make a complete exploration of the sunken city, the capital of the antediluvian empire. Mr. Donnelly even foreshadows such a realization, and suggests that it is not impossible that "the nations of the earth may yet employ their idle navies in bringing to the light of day some of the relics of this buried people," and that as a hundred years ago we knew nothing of Pompeii or Herculaneum, or of the Indo-European bond of languages, or of the monumental history of Egypt and the Mesopotamian empires, or of the ancient civilizations of Yucatan, Mexico, and Peru—"who shall say that one hundred years from now the museums of the world may not be adorned with gems, statues, arms, and implements from Atlantis, while the libraries of the world shall contain translations of its inscriptions, throwing new light upon all the past history of the human race, and all the great problems which now perplex the thinkers of our day?"

Report on the Meteorology of Tokio, for the Year 2540 (1880). By T. C. Mendenhall, Ph. D., Professor of Experimental Physics in Tokio Daigaku. Tokio, Japan: Published by the University. Pp. 81, with numerous Charts.

The present report covers the second year during which meteorological observations have been systematically taken at the University of Tokio. The tabulation of results is so arranged as to correspond in order with the tables of the previous year, and to facilitate comparison as much as possible. Hourly observations were maintained during March, June, September, and December, months which afford a good representation of the varying meteorological conditions of the year. In addition to these constant observations, an expedition was made to the summit of Fooseeyama to determine the force of gravity there; thermo-electric measurements of earth-temperature were undertaken, but abandoned on account of the difficulty of getting suitable insulating material; experiments were made with success for the determination of the velocity of the sound-wave under widely varying meteorological conditions; and co-operation in seismological observations is contemplated. It having long been known that the disastrous fires with which the Japanese capital is often afflicted are most frequent in certain months, and that their occurrence is intimately related to the direction and velocity of the wind, Professor Yamagawa, of the university, has devoted much time to an investigation of the origin and course of these fires, and to their classification in reference to atmospheric movement.

THE CHEMISTRY OF SAKÉ-BREWING. By R. W. ATKINSON, B. Sc. (Lond.), Professor of Analytical and Applied Chemistry in Tokio Daigaku. Tokio, Japan: Published by the University. Pp. 73.

SAKÉ is the beer of Japan, and is made from rice by processes similar in principle to those by which our beer is made from our grains, and which are described in their details in the course of this work. The Japanese brewers, it appears, discovered, three hundred years ago, a process for preserving their beer by heating it, thus anticipating a part of Pasteur's great discovery, but did not have the art of putting the heated liquor in perfectly pure germ-proof vessels, so that they omitted, after all, the most essential feature of Pasteur's process. It is only by repeated heatings, whereby its quality is injured, that they are able to keep their beer for a very considerable length of time. We learn, from the introduction to this work, that the annual consumption of saké in Japan is equivalent to about six gallons per head of the population. If the saké were diluted twice, so as to be of about the same strength as English beer, the consumption, twelve gallons a head, would be but little more than one third the consumption of beer in England, thirty-four gallons a head. "The brewing of saké is, therefore, of relatively less importance than that of beer in England, and this is doubtless to be ascribed to the enormous consumption of tea, which serves at all times, in summer and in winter, as the national beverage."

INFORMATION RELATIVE TO THE CONSTRUCTION AND MAINTENANCE OF TIME-BALLS. Prepared under the Direction of General W. B. HAZEN, Chief Signal-Officer of the Army. Washington: Government Printing-Office. Pp. 31, with Three Plates.

FREQUENT inquiry having been made at the Signal-Service office for information relative to the erection of time-balls, or other accurate time-signals, the general officer of the service addressed a letter of inquiry to the observers connected with the bureau who employed the balls, concerning the method of their construction and their operative machinery. The present circular of information is compiled from the replies to his inquiries.

PUBLICATIONS RECEIVED.

Programme of the Thirty-first Meeting of the American Association for the Advancement of Science, held at Montreal, August 23, 1882. Montreal: Published by the Local Committee. Pp. 215.

Address of Edward Atkinson at the opening of the Second Annual Fair of the New England Manufacturers' and Mechanics' Institute, in Boston, September 6, 1882. Boston: Franklin Press. 1882. Pp. 32.

The Growth of Children. By George W. Peckham. Reprint from Sixth Annual Report of the State Board of Health. Wisconsin. Pp. 46.

The International Time System. By Professor John K. Rees. From "Transactions of the New York Academy of Sciences." Pp. 10.

Annual Report of the Board of Directors of the Chicago Astronomical Society, together with the Report of the Director of the Dearborn Observatory. 1882. Chicago: Knight & Leonard. Pp. 56. Illustrated.

Extracts from an Old History of Louisiana. Translated. Pp. 19. Illustrated. Also, On the Transmission and Transformation of Nervous Diseases through Heredity. By Thomas Layton, M.D. Reprints from New Orleans "Medical and Surgical Journal." 1882. Pp. 22.

"The Modern Stenographic Journal." Vol. I, No. 1. Monthly. Buffalo, New York, September, 1882. Pp. 12. $2 a year.

Stricture of the Rectum. By Robert Newman, M. D. Reprint from New England "Medical Monthly." 1882. Pp. 7.

New Check List of North American Moths. By Professor A. R. Grote. New York. 1882. Pp. 73.

The Alphabet of the Future. By George H. Paul. 1882. Pp. 12.

Sixth Annual Report of the State Board of Health of Wisconsin. 1881. Madison, Wisconsin. 1882. Pp. 230.

The House-Fly considered in Relation to Poison Germ. By Thomas Taylor, M. D. 1882. Pp. 6.

Report of the Board of Commissioners of the Ninth Cincinnati Industrial Exposition. 1881. Pp. 314.

Report on the Character of Six Hundred Tornadoes. By Sergeant J. P. Finley. Washington. 1882. Pp. 19. With Plates.

Explosive and Dangerous Dusts. By Professor T. W. Tobin, Ph. D. Milwaukee. 1882. Pp. 14.

Dime Question Books. No. II. Literature. Pp. 35. No. III. Physiology. Pp. 37. No. IV. Theory and Practice of Teaching. Pp. 37. No. VI. United States History and Civil Government. Pp. 32. 10 cents each. Also, The New Education, by Professor Meiklejohn. Pp. 35; and A Small Tractate of Education, by John Milton. Pp. 26. 15 cents each. Syracuse, New York: C. W. Bardeen & Co.

On the Age of the Tejon Rocks of California and the Occurrence of Ammonitic Remains in Tertiary Deposits. By Angelo Heilprin. From the "Proceedings of the Academy of Natural Sciences of Philadelphia," July, 1882. Pp. 20.

Contributions from the Laboratory of the University of Pennsylvania. No. XX. Contributions to Mineralogy. By F. A. Genth. 1882. Pp. 24.

Historical Sketch of Greene Township. Hamilton County, Ohio. By C. Reemelin. Cincinnati: Robert Clark & Co. 1882. Pp. 33.

Nervous Control, or Equilibration. By James T. Searcy, M. D. From "Transactions of the Alabama Medical Association." 1882. Pp. 24.

Proceedings of the Biological Society of Wisconsin. With the Addresses read at the Darwin Memorial Meeting. Vol. I. November 19, 1880, to May 26, 1882. Washington. Pp. 110.

Easy Star Lessons. By Richard A. Proctor. New York: G. P. Putnam's Sons. 1882. Pp. 219. $2.50. Illustrated.

The Peak of Darien. An Octave of Essays. By Frances Power Cobbe. Boston: George H. Ellis & Co. 1882. Pp. 303. $1.50.

Constitutional History and Political Development of the United States. By Simon Sterne. New York, London, and Paris: Cassell, Petter & Galpin. 1882. Pp. 383. $1.25.

The Solution of the Pyramid Problem. By Robert Ballard. New York: John Wiley & Sons. 1882. Pp. 109.

Manual of Blowpipe Analysis. By H. B. Cornwall. New York: D. Van Nostrand. 1882. Pp. 308.

Essentials of Vaccination. By W. A. Hardaway, M. D. Chicago: Jansen, McClurg & Co. 1882. Pp. 146. $1.

Practical Life and the Study of Man. By J. Wilson, Ph. D. New York: J. Wilson & Sons, Publishers. 1882. Pp. 390. $1.50.

United States Commission of Fish and Fisheries. Report for 1879. A, Inquiry into the Decrease of Food-Fishes. B, The Propagation of Food-Fishes in the Waters of the United States. Washington: Government Printing-Office. 1882. Pp. 846.

Report of the Commissioner of Education for 1880. Washington: Government Printing-Office. 1882. Pp. 914.

POPULAR MISCELLANY.

The Glacial Moraine in Pennsylvania.—Professor H. C. Lewis read a paper before the American Association concerning the results of his efforts to trace the great terminal moraine marking the southern limit of the North American ice-sheet across Pennsylvania. The moraine had already been traced from Cape Cod across the Elizabeth Islands, Rhode Island, Long Island, and New Jersey, and across Ohio, Indiana, Illinois, Wisconsin, Minnesota, and Dakota, into the Saskatchewan region of the Dominion, but had not been remarked in Pennsylvania. Professor Lewis had found it entering the State near Easton, whence he traced it up and down to Potter County, and thence into New York State. Then it shortly turns to the southwest, enters Pennsylvania again, and passes into Ohio. It was thus traced for four hundred miles. It begins at a height of 240 feet above the sea, reaches 2,480 feet in Potter County, at the great divide between the waters that flow into the Atlantic and those that flow into the Gulf of Mexico; is 2,000 feet high at the extreme north point near Olean, New York, and is 800 feet high in Eastern Ohio, at the end of the portion examined. At the Delaware Water-Gap the ice did not pass down the valley, but across it. The Pocono Mountain was a promontory projecting northwardly into the ice-sheet. The glacial covering does not seem to have formed tongues pushing down in river-valleys, as is the case with modern glacier systems. Bowlders of labradorite and other crystalline rocks from the Adirondack and Ontario highlands were found all along the moraine line. In the discussion that followed the reading of his paper, Mr. Lewis asked Principal Dawson, as a leading opponent of the glacial theory, to explain certain facts according to his hypothesis of floating ice-fields. Principal Dawson replied, asserting that a continental ice-field in Northern America large enough to supply food for the alleged glacier was a physical impossibility, because, on account of the distance of this territory from open seas, the climate would be too dry for any such accumulation of snows. It was possible, however, that there might have been a river or a glacier which produced the moraine in that part of the country particularly referred to; but he could account for moraines in another way. Whenever a cold current infringes upon a warm current, it forms a moraine; and this is taking place in the region of the Gulf Stream. He himself owned a piece of land on the coast of the lower St. Lawrence, on which a very good moraine was now in course of formation.

The Gulf Stream.—The work of deep-sea soundings and determination of temperatures has been carried on continuously in the steamer Blake in the Gulf Stream for several years. The paper on the subject read by Commander Bartlett, at the recent meeting of the American Association, describes what was done in 1881 and 1882 under the direction of Professor Hilgard. The Gulf Stream does not run in a basin, nor is it divided into cold and warm alternate layers. The deepest bottom between Florida and the Bahama Banks is 459 fathoms below the surface, and the current runs from three to eight knots an hour, with a temperature of from 80° to 83° Fahr. A wide plateau exists off Florida, gradually narrowing as it goes north. Off the Carolinas it is forty or fifty miles wide. Near Savannah soundings were made at 1,840 fathoms. The 500 and 1,000 fathom lines are very close to the 100 fathom line north of Cape Hatteras and up to the Georges Bank off Massachusetts. Directly beneath the Gulf Stream is a hard coral limestone, with no loose material. The globigerina begins to appear at Charleston going north, and increases in amount. The cold water from the Arctic region flows inside the Gulf Stream off the American coast, and beneath it, falling down a depth of a thousand fathoms. The Bahama section showed a temperature of 44° at 459 fathoms, and washes in through the Windward Islands, south of Cuba, rather than through the Florida Channel. Outside the ridge, between Cuba and Hayti, the temperature descended to $36\frac{1}{2}$°, but the coldest found in the Gulf of Mexico was $39\frac{1}{2}$° down to 3,400 fathoms. There is no Gulf Stream in the Gulf of Mexico.

Indian Marriage Laws.—A paper on this subject, read by the Rev. J. Owen Dorsey before the American Association, notices some remarkable customs in relation to marriage and kinship as prevailing among the Dhegitha Indians, particularly the Omahas and Poncas.

When a tribe is hunting it camps, by *gentes* or nations, in a circle, each *gens* bearing the name of some animal. All the members of one gens are relatives, and marriage between members of one gens is absolutely forbidden. Membership in a gens is by descent in the male line, not in the female. The relations of a man are denoted by colors; for example—black, grandfather or grandmother; blue, father or mother. His connections are denoted by mixed colors, such as a pink head and skirt, with light-blue triangle on the body, for sister-in-law. A man can marry his brother's widow, and her children call him father even before their father's death. His sister's children are only nephews and nieces. His mother's sister is always called mother for the same reason, and even his paternal grandfather's brother's son is his father. These, and many other distinctions, show that the terms of relationship are far more numerous and complicated with the Omahas than with us. A man may marry any woman belonging to another gens, whether connected with him or not; though marriage into his mother's gens is also forbidden. A man can not marry any woman to whom he is related by the ceremony of the calumet-dance. Sometimes a man may take the children of his deceased brother without their mother herself. Sometimes the dying husband, knowing that his male kindred are bad, tells his wife to marry out of his gens. If a widower remains single for two, three, or four years, he must remain so for ever. Widows, however, must wait four years before remarrying. The same system prevails among the Iowas, Otos, and Missouris.

Hygiene in House-Walls.—Mr. T. R. Baker, in a paper read before the American Association, "On the Permeability of the Linings of House-Walls to Air," assumed that ordinary wall-paper made the walls of dwellings nearly air-tight. Hygienically considered, the walls of a house should be porous, like our clothing, so that our bodies can have through them, as also through our clothing, free intercourse with the external air. Compact wall linings, even if their minute pores are open, greatly interfere with this intercourse; but if their pores are closed with water, as when the walls are damp, it is almost completely cut off; and such linings increase the dampness of walls by preventing their drying in wet weather. The prolonged dampness also prolongs other evils produced by damp walls; therefore wall-papers and their substitutes should be condemned, and the old-fashioned whitewashed walls commended.

Succession of North American Flora.—Professor J. S. Newberry, describing the evolution of the North American flora, at the meeting of the American Association, said that the first flora was that indicated by the plumbago of the Laurentian formation. The kind of vegetation can not be determined. The second is in the Silurian. The evidence of actual vegetable origin is, however, defective; the objects may be corals rather than land-plants. The third flora is in the Upper Silurian; the fourth is in the Devonian. Two hundred species at least are described by Dr. Dawson, consisting of conifers, ferns, sigillarids, cycads, lycopods, etc. Several interesting varieties of this Devonian flora have recently been discovered in Ohio. The fifth flora is the Carbonaceous, the sixth the Liassic, and the seventh the Cretaceous, a flora containing broad-leaved plants of the angiosperms, which, with slight change, has continued to the present time. The Jurassic group is plainly cretaceous, and is entirely unlike the Tertiary. Not a single plant can be identified with any of the Old World tertiary flora. The various tertiary floras of the Rocky Mountains occur in the dried-up basins of old lakes. When the glacial period came on, the trees were entirely destroyed over the northern part of the continent. After the melting of the ice, the present flora made its appearance.

The Depression of our Atlantic Coast.—Professor George H. Cook, State Geologist of New Jersey, has presented, in a paper which he has read before the American Association, a large array of evidence showing that the Atlantic coast of our continent is gradually subsiding. It consists largely of the testimony afforded by the remains of ancient forests, composed for a considerable part of upland growths, which have been found in various places from the Carolinas to Greenland, either submerged at high water or at depths beneath the surface lower than the high-water mark of the neighboring coast, and at these places sometimes with present or former swamps over them. Sunken forests possessing some or other of these characteristics are mentioned as existing in the Carolinas and Georgia, where they were noticed by Bartram in 1773, Lyell in 1845, Professor Tuorney, of South Carolina, in 1846, and in Albermarle Sound, North Carolina, by Dr. Emmons. General Cutts, of the Coast Survey, has observed timber in the place of its growth several feet below the level of tide-water along the shores of Chesapeake Bay, in Virginia. The coast of New Jersey is marked by the occurrence of timber and stumps below the present tide-level in the marshes which border the State from the head of Delaware Bay to Cape May, and thence to the mouth of the Hudson. A marked example of yellow-pine stumps may be observed in the banks of the canal which connects South River at Washington with the Raritan. Similar submerged forests on Long Island have been described by Elias Lewis, Jr., in "The Popular Science Monthly." In Massachusetts, they have been observed at Nantucket, Holmes's Hole, Yarmouth, and Provincetown; in New Hampshire, at Rye Beach; in Maine, at Portland; and at the head of the Bay of Fundy in Nova Scotia. Other evidences are afforded by the subsidence of human structures since the period of settlement; in the flooding of farm-lands that have had to be abandoned, the submersion of boat-stakes, and the approach of the sea to buildings on the shore. Instances of this kind are observable at Southampton, Long Island, Barnegat, New Jersey, the shores of Delaware Bay, and on the west coast of Greenland. The encroachments of the sea at Long Branch and the changes going on at Sandy Hook are public facts. Professor Cook believes that the change thus marked is common to the whole northern hemisphere. It is certainly taking place in parts of Sweden. Some doubt has been thrown upon the theory of a subsidence from the fact that sea-shells and buried timber, both of kinds now living, have been found in deposits a few feet above the present sea-level. These instances are, however, regarded as belonging to another era than the present period of depression, and are distinguished by several important differences of features from those now under consideration. Professor Cook thinks that they belong to a previous period of depression; that the present period may not have been going on for more than five hundred or a thousand years, and that in the one which preceded it the surface of the upland was ten feet or more nearer the sea-level than it now is. He adds: "A careful study of the numerous cases like this will satisfactorily prove that there have been other periods of alternate depression and elevation in comparatively recent times, the phenomena of which are so nearly alike that they are very commonly confounded with each other. And, when they are clearly distinguished, it will be found that the rise or the depression is one common to our whole coast, and probably to the whole northern hemisphere."

The Esquimaux.—Dr. John Rae, in giving an account of his Arctic explorations before the American Association at its recent meeting, spoke of the Esquimaux as a generous and polite people, who had carefully preserved the tradition of events that happened twenty years ago. They believe they came from the West; and they seem to Dr. Rae physically like the Chinese. They build their huts and boats in a similar way with the Siberian natives, but appear very short in stature on account of the shortness of their legs. Dr. Flam, of London, had said that the skeleton of an Esquimau in his museum had thirty-five vertebræ, or one more than the average number. They are not to be regarded as gluttonous, for the large quantities of meat they consume seem to be required by the climate.

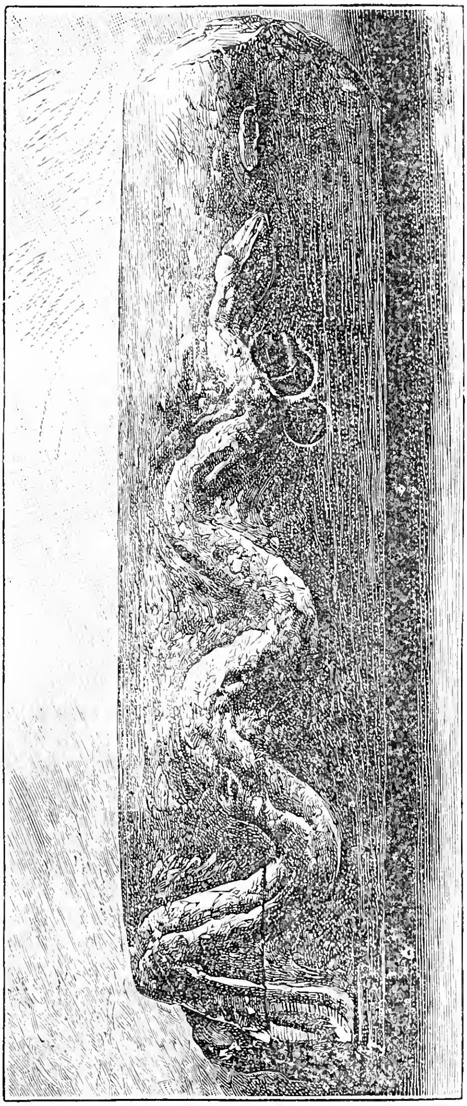
Apparent Size of Magnified Objects.—Professor W. H. Brewer reported to the American Association concerning some experiments he had made upon the estimation by different persons of the size of images of objects seen through the microscope. More than one hundred persons, of all ages, classes, and occupations, gave very many different estimates. A common louse was used as the test-object, and the magnified image was projected at ten inches. By far the larger number of persons underestimated the size value theoretically given the image by scientific microscopists, which was about 4·66 inches. Two estimates were of only an inch; several were of more than a foot. One student likened the figure to a cockroach, another to a lobster. Mechanics and artisans generally overestimate. A draughtsman, who was accustomed to measure and draw all his work, after careful examination said the image was at least five feet long! A professor of physics said he could make the image look of any size he wished.

Fossil Human Foot-prints in Nevada.—Several communications have lately been made to the California Academy of Sciences respecting what seem to be foot-prints of men which have been discovered in a sandstone hill in the yard of the State Prison at Carson City, Nevada. The hill is about sixty feet high, and stands at an elevation of 4,592 feet above the sea. It appears to have been formed by the deposition and drifting of sand upon what was the bed of an ancient lake. A surface of about three quarters of an acre has been cleared by quarrying to a depth of from fifteen to thirty feet, and down to the layer of arenaceous shale beneath the sandstone, which is supposed to represent the bottom of the lake. The tracks are in this shale. According to the description of Dr. Harkness, they are accompanied by the tracks of several animals—the mammoth, the deer, the wolf, the horse, and some birds—and are in six series of from eight to seventeen foot-prints each, in regular order, and each showing more or less plainly the imprint of a sandal. The first series, consisting of sixteen tracks, "were evidently made in a layer of sediment of, perhaps, two inches in depth, for below this layer we find the compact sandstone. In each instance the mud had been raised by the pressure of the foot into a ridge which entirely surrounded it." No single impression affords complete evidence that it was produced by a sandal, "but when we study them as a whole," says Dr. Harkness, "we find that what is wanting in one is furnished by others which follow." These tracks measure nineteen inches in length, by eight inches in breadth at the ball and six inches at the heel. The average length of the stride is two feet three inches. The distance between the feet, or the straddle, is eighteen inches. A second series of tracks was observed, made by an individual who was walking in deeper mud, which clung to and closed in and upon the foot. In another part of the area are four other series, at a level a few inches lower than those of the first series, smaller, and possibly made by moccasins. The toes of the tracks of the first series turned outward; "number two," says Mr. Gibbes, curator of mineralogy, in his account, "toed the mark, and walked as straight as a surveyor running a line. Series number three presents more irregular steps with toes turned out, possibly those of a woman bearing a heavy burden." Within the same area are the immense tracks of a mammoth, quite as plainly marked as the others, and, in another part of it, marks which Engineer Scupham, of the Central Pacific Railroad, describes as "confused tracks of a man and some large animal.

Only two or three steps of the man are distinct; then the confusion that appears to mark a struggle, and then the impression where a great body has fallen. After the struggle the great crane has waded about over the spot; its tracks winding in and out as if it had been avoiding with care the deep impressions made by the combatants, till at last, stumbling into one, it rises in startled fright. Farther to the north are many human tracks, all telling different stories of the track-makers." The question whether the foot-prints are really those of men is under discussion. Their size and the width of the straddle are against them. Professor Harkness suggests, however, that the sandal is not necessarily much larger than would be made to protect the side, as well as the heel and toe, of a foot twelve or thirteen inches long; and persons laboring in heavy mud would tend to make a wide straddle. The stride corresponds well with that of a man. Professor Joseph Le Conte, who also has examined the tracks, has expressed the opinion to the Academy that "no one who studies them can fail to observe their remarkable general resemblance to human tracks." He thought they might have been made by a human foot inclosed in a rawhide sandal much larger, externally, than the foot. He knew of no animal but a biped that could make such tracks; and this was possible for a man with sandals on to do. As a judicial mind, he desired to hold his final scientifically expressed opinion in reserve, awaiting further testimony. Several fossils have been found in the formation—tusks and teeth of elephants and horses, vegetable remains, and the fresh-water shells *anadonta* and *physa*. It is difficult to determine the exact age of the strata, but they are generally agreed to be either Quaternary or Pliocene.

The Infant Giant Jaw-Bone of Stramberg.—The Congress of Austrian Archæologists, recently in session at Salzburg, was the scene of an interesting discussion of the human jaw-bone, in which the proportions of a giant were found associated with the teeth of a child, which was dug out, at Stramberg, in Moravia, from under a formation containing bones of the reindeer, snow-owl, cave-bear, and other Arctic animals. Professor Schaffhausen maintained that the jaw was one of a child, of between eight and nine years old, in which the change of teeth was going on. The incisors had already changed, and an eye-tooth and the premolars were developing in the jaw, and would have appeared after the usual time. The incisors showed considerable use. The height and thickness of the jaw and the size of the teeth reached the dimensions of those of a full-grown man of our time, and even surpassed them in some respects. The forward part of the jaw retreated so much as to obliterate the chin. These marks, similar to those that are observed in a still higher degree in other diluvial jaws, show that we have to deal with a man of very low organization. Professor Schaffhausen rejected the idea that the development of the teeth had been prevented by a pathological cause. Virchow opposed both the view that the jaw was like that of an ape and the one that it was a child's. The case was a rare instance of heterotopy in a man of gigantic size. The jaw was submitted to a committee, who subjected it to a careful examination and comparison. No one's views were changed, but the committee reported that the proportions of the teeth considerably exceeded those of a child's teeth, and reached those that are attained only in a full-grown man; it discovered nothing ape-like in the chin, but found, on measuring it, that, instead of retreating as it appeared to do, its line was perpendicular to the upper surface of the incisors, taken as a horizon. By carefully cutting away the plaster that held the left larger incisor in the preparation, an extraordinarily thick and plump root, rounded below, and quite different in its proportions from the normal, was brought to view; and the committee advised that the preparation of the specimen made by Professor Virchow be revised, so that the jaw could be subjected to a more thorough examination.

A Lignified Snake.—Naturalists are indebted to Senhor Lopez Netto, Brazilian Minister to the United States, for introducing to their attention a specimen of a phenomenon which, although it had been regarded as possible, had never before been observed—that of an animal turned into wood. The specimen is that of a snake called the jararaca, one of the most venomous reptiles of the province of Matto Grosso, in Brazil, which, having crept into a crack in the bark of a tree, has died there, and afterward become lignified. As the cut shows, but less plainly than the specimen itself, the head, neck, and other parts of the animal are clearly delineated, and the most delicate details of the organization are plainly visible in many regions—as in the nostrils and the eye-cavities, and in the disposition of the scales and the cephalic plate on a whole half of the surface of the head. And the identity of the figure with the little jararaca of Brazil has been acknowledged to be evident by persons who are acquainted with that reptile. M. Louis Olivier, of the Botanical Society of France, who has made an anatomical examination of the figure, reports that he has found it to be composed of cells and fibers like those of the secondary wood which surrounds it. "The formation," he says, "can not be explained by saying that it has resulted from the deposition of the elements in a hollow, which, having been traversed by the animal, has preserved its form; for not only the contour of the serpent, but the whole relief of his form, is recognizable in the wood. The entire body of the animal has been thus lignified, except the center, where the constituent elements of the animal still exist. Following the line of the projection of the head may be seen a cylindrical figure, also in relief, which seems to represent the larva of an insect. The deduction is therefore drawn that the reptile, pursuing the insect into a crack in the tree, had insinuated itself between the wood and the bark, or into the zone of the cambium, out of which the wood and inner bark are formed. Having died there, it went through the process of decay, in the course of which each animal particle as it was dissolved was replaced by a particle of woody tissue deposited by the cambium. The specimen was exhibited to the Botanical Society of France on the 9th of April last, when, as we learn from a note from M. Olivier to Senhor Netto, there were present M. Bonnet, President; M. Chatin, General Secretary, etc.; M. Duchartre, Professor in



THE LIGNIFIED SNAKE OF MATTO GROSSO (one half the size of nature).

the Faculty of Sciences, etc.; M. Prillier, Professor at the Central School of Arts and Manufactures and at the Agronomic Institute; M. Malinvaud, Secretary and Librarian of the Society; Dr. Edmond Bonnet, of the Museum of Natural History; and M. Paul Petit. "These gentlemen, after having examined the specimen submitted to them, with the most lively interest, agreed, in explanation of the remarkable phenomenon which it presents, that there has been a gradual substitution of ligneous fibers and cells for the constituent elements of the snake. The reptile had introduced itself into a fissure of the tree between the wood and the bark, and had died there; and as rapidly as its flesh decayed the place which it had filled was occupied by the cells produced by the generative zone of the secondary wood, that zone becoming hypertrophied on contact with the animal, as is attested by the well-defined relief which it still presents. No objection was opposed to this interpretation of the facts; but in admitting the same explanation which I had endeavored to give you before the meeting, neither my colleagues nor myself intended to depreciate the importance of the phenomenon which is the object of it; the wood of the formation of the vegetable tissues appears sufficient to give an account of it. It is no less true that, in the opinion of the most competent persons, the specimen which you have made known to the scientific world is the finest example that has so far been brought forward in illustration of the theory of the normal play and accidental hypertrophy of the generative tissues of plants." The specimen was also shown to M. Van Tieghen. He was very busy, and able to give it only a cursory examination; but the opinion he expressed concerning its nature was fully in accord with that of his fellow-botanists. Dr. Edmond Bonnet and D. Adanson had recollections of specimens presenting similar characteristics to a certain extent, but declared that no known specimen offered nearly so complete an exemplification of the wonderful phenomenon of transformation as this one. The editors of this journal have been permitted, by the courtesy of Senhor Netto, to inspect the specimen, and are glad to add to that of the French botanists their testimony to its remarkable character.

Progress of Scientific Forestry.—Sylviculture, or the culture of forests, as it is understood and applied in the countries of Europe, where it has been studied as a science, is the application to woodland property of certain economical principles which, in their spirit, contain nothing more than what is held to be necessary for the well-ordered management of landed property in general; and which may be summed up as follows: 1. The obtaining, within approximate limits, of a regularly sustained revenue from the land which the forest covers. 2. The utilization, to the fullest extent possible, of the natural productive powers of the soil. 3. Progressive improvement in the value of the property. 4. Final realization of the crop to the greatest advantage. "It is in the development of these principles," says Colonel G. F. Pearson, in a lecture before the British Society of Arts, "and in their application to forests of different sorts, that the true science of forestry consists." The rapid disappearance of the forests first attracted attention, in Europe, at about the beginning of the seventeenth century. The first measures to regulate the evil were not very efficient, but the subject came under the attention of the distinguished naturalists of the succeeding generations, and a system —that of *tire et aire*—was adopted. Under this system a period called a revolution was fixed, in which the forest was destined to be cleared off entirely, and reproduced by natural seeding. To this end the wood was divided into a number of compartments equal to the number of years in the revolution, one of which was felled every year, or at such regular intervals of time as were determined in the working plan, a few standard trees only being left as seed-bearers. This system was continued till within the last half-century, but did not prove efficient; and any approach to sound forestry was unknown in France till the forest-school was established at Nancy, in 1824. Considerable progress had been made before this time, even before the close of the last century, by the German foresters, who were the first to base the principles of the art on observation, and treat it in a scientific manner. Schools of sylviculture now exist in all the principal countries of Europe, except Great Britain; and Dr. Hough, of the United States, last year visited all the forest-schools of Europe, with a view of founding an American school. Considerable progress has been made in forestry in India, where steps for forming a regular forest administration were taken immediately after the mutiny. A policy of sending candidates to foreign schools to be trained has given the state a body of able men, thoroughly grounded in the management of natural forests covering extensive tracts of country. Within the last two years the Cape of Good Hope and Cyprus have been furnished with forest officers from France. The Mauritius, Ceylon, the Straits Settlements, Hong-Kong, Feejee, and other British colonies, are all following suit, and have recourse to Kew and other similar institutions for foresters. Of all the British colonies, South Australia is the one that is giving most attention to the subject. More would, undoubtedly, be accomplished in all the colonies had Great Britain a central institution for training a sufficient number of foresters to supply their needs.

Egypt as a Health Resort.—In estimating the merits of Egypt as a winter residence for invalids, Dr. Edith Pechey specifies dryness and equableness of temperature as the characteristics of climate chiefly demanded for such a purpose. Of the former quality one soon has practical proof in a Nile voyage. The hair gets very dry, the nails grow slowly and are very brittle, and all articles of use in some way give testimony of it. The air becomes drier with the ascent of the river, "and the dry heat is more easily borne than moist heat. One experiences no discomfort from the increase of temperature as one approaches the tropics; in fact, one thoroughly enjoys there what in Lower Egypt would be found quite oppressive." Egypt is not exempt from occasional sudden and great changes of temperature, but they are rare. Of much greater importance are the variations. The temperature falls suddenly at sunset for about half an hour, and another depression takes place in the early morning. The changes are very evident in a wooden boat, and from this fact constitute a great drawback in the dahabeeah voyage for invalids. In Nubia, the diurnal variation is much less marked, and the nights are only pleasantly cool. The life on the dahabeeah is a very enjoyable one, and "for cases of overwork nothing could be devised more calculated to restore and strengthen the intellectual powers than the Nile trip, and here no physician need hesitate for a moment. There are perfect rest, no railway bustle or jar, the variety of traveling in fact without the fatigue, with the constant enjoyment of sunshine and fresh air." Phthisical and rheumatic patients will also be greatly benefited, if they are careful in guarding themselves against the night and morning chills.

Cowries and African Currency.—Herr John C. Hertz has published a memoir, in the "Transactions of the Geographical Society of Hamburg," on the use and diffusion of the cowrie-shell (*Cypræa moneta*) as a medium of exchange. The author's father dispatched a vessel to the Maldive Islands in 1844 for a cargo of cowries, to be sold to merchants for use in West African trade. Not finding as many shells there as they had anticipated, they completed their cargo with the larger and less valuable species of Zanzibar, where the cowries are burned into lime. Several cargoes of cowries were sent annually to Whydah and Lagos, where they were exchanged with the slave-traders for the Spanish doubloons they received from the sale of slaves. The Hamburg ship-captains dispatched this money home from Cape Town. The cowrie-trade continued to extend as the slave-trade flourished, till Brazil took measures to prevent the introduction of African slaves. Simultaneously with the extinction of the slave-trade began the introduction of palm-oil, and a new trade, in which that product took the place of the Spanish doubloons, that grew as the use of palm-oil was extended. It flourished greatly during the Crimean War, when the Black Sea tallow was excluded from the markets. With it also flourished the trade in cowries, which thus appears to be connected with so many historical events that, considered from that point of view, it may be regarded as in some sort a measure of historical development—a view which received another exemplification in 1852, when England blockaded the coast of Dahomey, and the trade in cowries was stopped. In 1845 the Sultan of Bornoo reformed his currency, and introduced Spanish doubloons in place of the cotton-cloth that had hitherto served as money, with cowries, at the rate of four thousand to the dollar, for small change. A large demand for cowries sprang up, and the trade in them was stimulated to such an excess that the market was glutted, and it afterward languished for several years. The present demand is quite lively. The cowrie-shell is used as currency principally in the countries near the Niger, except in Ashantee, where gold-dust is the medium of exchange. North of Ashantee, gold-dust and the gera or cola-nut (*Sterculia acuminata*) are used with cowries, a load of sixty pounds of the nuts being considered equivalent in value to about fifteen thousand cowries. The shells have been used as a medium of exchange from a high antiquity. Marco Polo found them circulating in Yunnan in the thirteenth century; and they have been discovered in prehistoric graves in the Baltic countries. Herr A. Wörmann says, in a paper of the Hamburg society, on trade by barter in Africa, that a variety of objects besides cowries serve as measures of value in the different countries of that continent. Among them are pearls, little Nuremberg looking-glasses, iron, copper, brass, cloth, salt, tobacco-leaves, writing-paper, the cola-nut, goats, horses, cattle, and slaves; and the regions in which each of these articles circulates are defined by fixed limits. Iron and copper from Egypt circulate in the upper Nile region; Maria-Theresa thalers and cowries in Soodan; cowries, pearls, and "Mericani" (unbleached goods) on the East coast and in the region of the Arab trade. South and west of these countries are distinct trade-regions that have no direct connection with them, in each of which a different currency is needed, although ivory and slaves are the only products.

Shooting-Stars, their Traditions and their Origin.—The appearance of comets and shooting-stars announced to the ancients and to our ancestors the death of some grand personage or some woe, and the chronicles are full of notices of such phenomena. The notices are, in fact, occasionally so numerous as to be suspicious, for, as Lubienietz remarks in his "Cometography," when an event of such a kind happened, it was thought there must have been a comet about the time, and so it was put down; and an amusing picture has been made of the perplexity of a cometographer who could not find any comet for seventeen years, portentous of the events that were to happen during that period. The Chinese records are more trustworthy, for their observers were constantly at their posts, and formed a regularly and scientifically organized body. The documents recording the observations were specially preserved; for the Chinese, from a time many centuries before the Christian era, attributed to the different stellar groups a direct influence on the different provinces of their country. As shooting-stars may be seen at almost any time, it was to be expected that a great number of notices of the phenomena must have been recorded during the forty centuries of which we have a literature of some kind. Plutarch, in his biography of Lysander, makes a near approach to the modern explanation of the origin of these bodies, saying, "Some philosophers believe that the shooting-stars are not detached parts of the ether which go out in the air soon after they have been inflamed, that they no more originate in the combustion of the air which is dissolved in great quantity in the upper regions, but that they are rather falling celestial bodies." The general opinion is, that shooting-stars are bodies of small dimensions that circulate, under the influence of attraction, among the planets in the same way as the planets themselves. When they cross our atmosphere, the friction develops heat enough to consume them, most frequently before they reach our soil. The mean height at which the meteors become luminous exceeds, however, the estimated height of our atmosphere. Poisson has, therefore, suggested that, as they could hardly have become inflamed from friction at such a height, an atmosphere of neutral electricity may exist considerably beyond the mass of the air which is subject to the earth's attraction, and is disturbed by the entrance of the meteors, so that they become electrified and incandescent. Any theory to account fully for the origin of shooting-stars must explain the periodic swarms. For this reason, the theory of ejectment from lunar volcanoes must fail, even were it not otherwise shown to be baseless. M. Faye accounts for the August meteors by supposing a meteoric belt circulating around the sun which crosses the ecliptic at a point where the earth must meet it at the time of the annual shower, but this leaves the November meteors still unexplained. Schiaparelli and Le Verrier have suggested that the November meteors originate in a swarm of corpuscles which move in orbits very close to each other, having a period of about thirty-three years, and elements very similar to those of Temple's comet. Schiaparelli also connects the August meteors with the comet of 1861, and other swarms have been similarly connected with different comets. The Chinese annals furnish data which indicate that the greater number of shooting-stars are seen when the earth is passing from the summer solstice to the winter solstice, and this appears to be confirmed by the phenomena of the August and November meteors. The ancients and the authors of the middle ages abound in notices of portents, falling stars, fiery spears, fiery swords, burning skies, showers of blood, etc., a large proportion of which may be referred to shooting-stars. The earliest record so far found is the statement that Zoroaster was destroyed by fire, assigned to 2057 B. C., and the next the destruction of Sodom and Gomorrah, 1915. Many of the middle-age accounts give the phenomena the appearance of armies and battles in the sky.

NOTES.

Mr. Leonard Waldo, of the Thermometric Bureau of the Observatory of Yale College, reports that more than twice as many thermometers were examined in 1881–'82 as in 1880–'81, and that 4,552 certificates were issued during the year covered by the last report. The attention of the bureau has been directed to the study of a test for the sensitiveness of thermometers, or for the time required for each instrument to reach its maximum. A sufficiently delicate, simple test to meet the conditions of medical practice has not yet been devised.

President Charles E. Fay, of the Appalachian Mountain Club, considered the nomenclature of mountains and rivers in his last annual address. A good name, he suggested, should be individual, and suggestive of no other object than the one to which it is applied. The Indian names are excellent for that reason, and because in the nature of things they can have no other meaning for us than their special one. Personal surnames are not so objectionable as they may seem to be, for, unless they are derived from very conspicuous persons, they may in time lose their associations with individuals and become merged in the identity of the mountain. The names of the "Presidential Range" are among the most objectionable of this class, because of the difficulty of shaking off their associations with the Presidents. Artificially formed names are apt to be awkward and hard to naturalize; and descriptive names, unless they are rarely well chosen, are liable to degenerate toward the commonplace and irrelevant.

Mr. W. A. Hazen, in a paper on "Air-Pressures west of the Mississippi River," published by the Signal Service, suggests that the position and extent of areas of high pressure in the region of Montana during the winter months may have a very important bearing upon the meteorological condition of the whole United States. His view is based upon the fact that in November and December, 1880, a permanent area of high pressure existed in Montana, and extended over an immense territory, and the winter was extremely cold over the entire country; while in November and December, 1881, the area of high pressure was less marked and was to the west of the Rocky Mountains, and the cold of the winter was likewise very much less marked. Many more years of observation will, however, he concedes, be necessary before any fixed law can be established.

The death is announced of Professor Leith Adams, of Queen's College, Cork. As a surgeon-major in the army, he received much praise for his report on the epidemic cholera in Malta, in 1865. Having retired from the army in 1873, he was appointed Professor of Zoölogy in the College of Science, in Dublin, and afterward, in 1878, Professor of Natural History, at Cork. He was author of "Wanderings of a Naturalist in India," "The Western Himalayas and Cashmere," "Notes of a Naturalist in the Nile Valley and Malta," and works on the "Natural History of Eastern Canada," and on "British Fossil Elephants."

The "Gazette Maritime et Commerciale" relates, in its column of marine accidents, a curious instance of the formidable power of molecular forces. The Italian ship Francesca, loaded with rice, had put in at East London, leaking badly. A squad of workmen was put on board to pump the vessel out and unload it; but, in spite of all their diligence, the rice absorbed the water more rapidly than they could discharge it, and swelled until it forcibly burst the vessel to pieces.

A TELEGRAPHIC despatch from Göttingen, Germany, September 25th, announces the death of the chemist Friedrich Woehler, Director of the Chemical Institute at that place. Professor Woehler was born in 1800, and was appointed to his position in the Institute at Göttingen in 1836. Among the important chemical discoveries with which he is credited are those of a new method of obtaining nickel pure, and the isolation of the metal aluminium, for which he was elected a chevalier of the Legion of Honor. His text-books on organic and inorganic chemistry are much used in German schools. He contributed many original papers to the German chemical journals.

OUR readers will remember our account of the experiments of Mr. Bjerknes, of Christiania, Norway, in the production of phenomena similar to those of electrical and magnetic attraction and repulsion by means of hydro-dynamic, mechanical action. Mr. Stroh has performed a series of similar experiments, and has produced phenomena similar to those obtained by Mr. Bjerknes, by means of sonorous vibrations in the air. He uses a melodeon reed, the sound of which goes into a brass tube in which the reed is inclosed, and from this into a larger tube, to which is attached a bifurcating India-rubber pipe, each branch of which ends in a tambour. The vibrations may be made consonant or dissonant by adjustment of the lengths of the India-rubber tube branches. When the vibrations are consonant, the tambours are attracted toward each other; when the vibrations are dissonant, they are repelled. If a tambour in a state of vibration be presented to a disk which is not vibrating, attraction takes place. Thus, the phenomena of attraction and repulsion are imitated in air as Mr. Bjerknes has imitated them in water, except that they present themselves in an inverse sense from that in which they are exhibited under electric and magnetic influences.

DR. STEPHEN D. PEET maintains, in a paper on the "Prehistoric Architectures of America," that they differ from those of any other continent, in that they exhibit architecture in its lowest stages, and at the same time give a clew to its development throughout all its stages. They may thus be used to aid in the study of the early stages of historic architecture in other lands. They, in fact, illustrate the transition between the prehistoric and the historic states. In Europe, only the highest class of prehistoric works can be called architectural; in America, the lowest class are worthy of that name. The American works, therefore, begin where the European ones leave off. Beginning at a point where architecture is presented in an undifferentiated state, the prehistoric works of America show a connected line of progress, especially observable in the gradation which is apparent in the works of the different sections of the continent as we go from the east to the west.

MR. LUCIAN J. BLAKE, of Boston, who is studying at Berlin, on the Tyndall Scholarship, communicated to the Prussian Royal Academy of Sciences, on the 15th of June, through Professor Helmholtz, a paper on the "Electrical Neutrality of Steam rising from Still Surfaces of Electrified Water." He describes a series of experiments from which he draws the conclusion, contrary to the theories of Becquerel and Sir William Thomson, that in steam arising without ebullition, when no spray is thrown up, no convection of electricity takes place. He is continuing his experiments to confirm this law.

DR. D. G. BRINTON, of Philadelphia, is about to begin the publication of a series of works to constitute a "Library of Aboriginal American Literature." Each work will be the production of a native, and will have some intrinsic importance in addition to its value as a linguistic monument. The books will be printed in the original tongue, with an English translation and notes. The first volume, "The Chronicles of the Mayas," will contain five works, written in the Maya language, shortly after the Spanish conquest of Yucatan, and carrying the history back several centuries, four of which have never been published or before translated into any European tongue, with a history of the conquest written by a Maya chief, in 1562, also from an unpublished manuscript, and a history of the Mayas. It will be published before the end of the year, and will be furnished to subscribers at three dollars a copy.

THE annual congress of the German Anthropological Society met at Frankfort, August 14th. About five hundred members were present. The president, Professor Lucae, delivered the opening address on the development of anthropology during the last ten years, and was followed by Dr. Schliemann, on his latest excavations at Troy; and Professor Virchow, on Mr. Darwin's relations to anthropology.

A FAMOUS rose-bush at Hildesheim, in Hanover, which is said to be a thousand years old, and is reputed to have been planted by Charlemagne, has this year been covered with an extraordinary profusion of blossoms—more, it is declared, than it was ever known to bear before. New shoots have been grafted on its stems within a few years, and have grown finely. The bush stands on the outer wall of the crypt of the cathedral, with branches reaching to more than thirty feet in breadth and nearly thirty-five feet in height.

MATTHIAS JACOB SCHLEIDEN.

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MR. GOLDWIN SMITH ON "THE DATA OF ETHICS."

By W. D. LE SUEUR, B. A.

"Because we must not dream, we need not then despair."
—Matthew Arnold, *in Empedocles on Etna.*

MUCH instruction has been drawn from the story of Naaman, the Syrian, who, when he went to the prophet Elisha, to be healed of his disease, expected that the man of God would "do some great thing," and was greatly discouraged and offended when he merely recommended him to go through a strenuous course of ablution in the most convenient stream. There is one application, however, of the narrative which we do not remember to have seen made, and yet which is undoubtedly important. The prophet of olden times is represented to-day by the philosopher, who also leads a life of retirement and severe contemplation. And just as the contemporaries of the prophet insisted on investing him with magical powers, while they undervalued his real gifts of practical sagacity and spiritual insight, so do the men of to-day demand of the philosopher to "do some great thing," while they scorn the demonstration he offers that the truth has neither to be brought down from heaven nor up from hell, but is very nigh them—in their hearts and on their lips. Such errors are to be expected on the part of the multitude; but there are men who, from their general breadth of view and clearness of perception, might be expected to do justice to a scheme of philosophy just in proportion to its avoidance of extravagant pretensions, just in proportion as its author had visibly aimed at learning from nature rather than imposing upon nature his own preconceptions. Of the class of men to whom we refer, no higher example could be found than Mr. Goldwin Smith: of the kind of philosophy to which we refer, no better type could be found than that of Mr. Herbert Spencer.

And yet, unless our own judgment is fatally at fault, Mr. Smith, one of the very best-furnished critics of modern times, has signally failed to do justice to Mr. Spencer's philosophy, or at least to the portion of it embodied in his last volume but one, "The Data of Ethics." The article contributed by Mr. Smith to the "Contemporary Review" for February of this year constitutes the most serious attack, by far, that has been made upon the volume in question. To mention Mr. Smith as its author is to vouch for the force, perspicuity, and felicity of the style, and for a large infusion of that common-sense philosophy which carries persuasion to the general reader. Many have read that article who never read "The Data of Ethics"; and we have little doubt that the opinion of these in regard to the questions at issue has been largely molded by it. In these days of rapid literary production it is a rare thing to find an article remembered three months after it is written; but Mr. Smith's article still finds echoes in many quarters of society, and particularly from the pulpit. It can not, therefore, be considered too late to submit it to a careful examination, in order to see how far Mr. Spencer's positions have really been shaken by the arguments brought against them.

Mr. Spencer's book is essentially a study of human conduct (purposive action) in its origin and development, with a view to discovering the nature and sanctions of morality. That it is of the utmost importance that men should feel strongly the distinction between right and wrong Mr. Spencer everywhere implies; and his object is to place that distinction on a basis which, if not so imposing as that heretofore furnished by theology, may at least not be subject to the vicissitudes which seem to be the portion of all theological codes. We must presume our readers to be more or less familiar with the work in question, and to have followed Mr. Spencer in his demonstration that, as purpose takes a wider range, it gathers to itself an accompaniment of moral emotion. In connection even with self-regarding actions, a certain sense of moral power accompanies every subordination of an immediate impulse to one more remote. The individual awakens to a sense of the capacity for *choice*, and the foundations are thus laid for moral freedom. It is, however, the life of the family, the tribe, the community, that lends the greatest enlargement to individual thought and feeling. Care for offspring comes first to break down the tyranny of exclusive regard for self. The family develops into the tribe, and men learn to practice a certain measure of justice toward one another as the essential condition of co-operation. The increasing harmony of outward relations has its inward counterpart in increased strength and breadth of sympathy. The moral quality of an action depends upon the degree in which it tends to promote or diminish happiness; but this, as Mr. Spencer repeatedly points out, is in most cases to be determined rather by the conformity or non-conformity of the action with certain general principles ascertained to be favorable to happiness than by an inquiry into the results likely to flow from it in a special case. Moral actions, in general, are those favorable to life, not only to its preservation, but to its improvement ; immoral actions are those which tend to the shortening or to the impoverishing of life. In speaking of life here, we speak not only of the condition of animation, but of all that successive experiences, successive enlargements of the range of thought, action, and sympathy, have built into, or worked into, the human consciousness. To help forward this work of integration is good ; to retard or counteract it is evil. In common speech the terms good and evil are upon the whole applied to actions just in accordance as they tend, or are believed to tend, in one or other of these directions.

As the aim of all voluntary action is the furtherance of happiness, the test of perfection in an action will be its fully accomplishing that object. A man who procures a momentary gratification by some unwholesome indulgence has not performed, even from a selfish point of view, a perfect action, seeing that its effects are partly, at least, destructive of the end he has in view. The man who, losing his temper, quarrels with a neighbor, does not, even from a selfish point of view, perform a perfect action ; for, whatever satisfaction he may derive at the moment from the utterance of angry words, he can derive no benefit, but only the reverse, from the subsequent alienation of his neighbor's feelings. From a social point of view, no action is perfect which benefits only the actor, or which benefits some one else at the actor's expense. Self-sacrifice may be ethically noble ; but that any necessity for it should arise implies some defect in the conditions of existence, and therefore of action. If it enables us, on the one hand, to estimate the moral resources of humanity, it points, on the other, to evils which it behooves us to remedy ; for why, we ask, should the gain of one be purchased by the loss of another ? To find a perfect action, therefore, we must look for one all the effects of which, so far as they can be traced, are good, which not only involves no sacrifice of happiness, either to the actor or to the person who is the object of the action, but which is equally beneficial to both. Social evolution being a manifestly unfinished process, the region of the social activities can not be expected to furnish the best examples of perfect adjustment. In searching for such an example, Mr. Spencer therefore falls back, in the first place, on the physical region, and cites —to Mr. Smith's great amusement and scorn—the case of a mother suckling her child. We quote his words :

> Consider the relation of a healthy mother to a healthy infant. Between the two there exists a mutual dependence which is a source of pleasure to both. In yielding its natural food to the child, the mother receives gratification ; and to the child there comes the satisfaction of appetite—a satisfaction which accompanies furtherance of life, growth, and enjoyment. Let the relation be suspended, and on both sides there is suffering. The mother experiences both

bodily pain and mental pain; and the painful sensation borne by the child brings, as its results, physical mischief and some damage to the emotional nature. Thus the act is one that is to both exclusively pleasurable, while abstention entails pain on both; and it is consequently of the kind we here call absolutely right.

Here we are asked to recognize the *reductio ad absurdum* of Mr. Spencer's whole system of ethics. For our own part, we wholly fail to see where the absurdity comes in. If what we are in search of is a type to which *all* actions might advantageously conform, where, we ask, shall a better be found than this? What would the condition of society be if all the actions of men conformed to this type, blessing alike the doers and those toward whom the actions were directed? There is but one answer: it would be perfect. The end of all ethical self-discipline, the end of all social adjustments, is precisely to bring things as nearly as possible to this consummation. The good man, in the highest sense of the word, is he who loves his neighbor as himself; in other words, who desires that his action shall benefit his neighbor equally with himself, and not one neighbor only, but all neighbors, and who, therefore, regulates his actions with a view to universal utility. And in all social reforms what is it that we desire to bring about but this—that one man's gain shall not be another man's loss, but that the gain of one shall be the gain of all?

Mr. Smith places in contrast with the typical action chosen by Mr. Spencer the case of an Italian physician who courted the infection of a deadly plague in order that he might, for the benefit of his stricken fellow-citizens, the better understand and describe its symptoms and development. But is that the type to which we should wish *all* human actions to conform? That there should be such actions, we must, in the first place, have plagues; and in order that we may have plagues we must have ignorance and filth. Would it really be worth while to order these things, to the end that one Italian physician might, by an act of sublime self-sacrifice, shed one ray of light athwart the general gloom?

Mr. Smith says that, according to Mr. Spencer, "the action of the Italian physician . . . is ethically inferior to that of a Caffre woman suckling her child." This, however, is misleading. Though Mr. Smith speaks of *actions*, the contrast which his words suggest is between *motives*. When we want to estimate the quality of an action in relation solely to the doer, motive is everything; but, when we desire to estimate its intrinsic value as a link in the net-work of human activity, motive must be left out of sight. The motives of the Inquisitors were, we may presume, good, but their deeds were diabolical. The motive in this case was of the highest possible order; but, when the act was completed, a noble life had been sacrificed. How can an act which inwraps so much of irreparable loss be classed as perfect?

More important still is it to remark that Mr. Spencer distinctly assigns the action which he cites to a lower plane altogether than that to which the action of the Italian physician properly belongs. These are the words with which he introduces his illustration: "Among the best examples of absolutely right actions to be named are those arising where the nature and the requirements have been molded to one another *before social evolution began.*" (The italics are ours.) The adaptation found subsisting between mother and child was established in a pre-social period; and, though social evolution has since been carried forward many stages, the relation in question retains its character as an almost wholly physical one. No doubt maternal love is to-day a much tenderer and more complex thing than in savage days; but, as the higher affection is not always guided by adequate knowledge, we must still look to the physical adaptation as the highest example of perfect adjustment. The action of the mother nourishing her child is "absolutely right," but "absolutely right" in a comparatively low sphere of conduct; the action of the Italian physician is only "relatively right," but it is "relatively right" in a much higher sphere of conduct. It is, therefore, not correct to say, without careful qualification, that, according to Mr. Spencer's philosophy, "the action of the Italian physician is ethically inferior to that of a Caffre woman suckling her child." What may be said of it is that it is *typically* inferior, although ethically higher; that is to say, less adapted to serve as the type of perfect action, though indicating the presence of far superior moral elements. The distinction is not difficult to seize.

The precise position from which Mr. Smith makes his attack on Mr. Spencer is not very easy to discern. He evidently does not like the evolution philosophy in its application to morals; and yet it is not very clear that he takes his stand distinctly on any other. A most critical time, he thinks, has arrived in the intellectual development of society, and what the result is going to be he does not venture to predict. Serious breaches have been made in the defenses, not only of revealed, but of natural religion; the theistic hypothesis itself is threatened. The breaches *may* be repaired—Mr. Smith does not feel at all certain one way or the other; but meanwhile he thinks it a safe thing to point out the deficiencies of the evolution philosophy as compared with a theistic philosophy. But supposing the breaches should *not* be repaired, but, on the contrary, widened; and supposing we should have in the end to fall back on the evolution philosophy or something like it, would it not then be the part of wisdom to make the most of it—to show it in the most favorable, rather than in the least favorable, light? Mr. Smith seems to us to be somewhat in the position of a man battering a house in which, according to his own admission, he may some day have to live. Supposing the evolution philosophy to be true, or to be an adumbration of the truth, any defects we may discover in it are simply defects in the constitution of things as compared with our former conceptions on the subject; and finding fault with the constitution of things is not the most profitable of employments.

Among the objections brought by Mr. Smith against a naturalistic morality, the following seem to be the principal:

1. It would not favor such acts of devotion as are now prompted by "the ideas and hopes" of religion.

2. It can not explain to us why a man surrounded with all imaginable worldly comforts, but with a murder on his conscience, is unhappy, while a man who gives his life for others is happy in the act.

3. It can not attach any meaning to such words as "the sacredness of human life."

4. It furnishes no basis for moral approval or condemnation.

Let us attempt to deal with these objections in the order in which they stand:

1. In regard to acts of devotion, it will be observed that Mr. Smith speaks somewhat hesitatingly. Referring to the manning of a life-boat for some perilous enterprise, he asks if we are "sure" that the men would not be less ready to take an oar were they told that death would make "an end for ever of them and of their connections with those whom they loved." Well, we are *not* sure what the effect would be of a sudden and most untimely announcement of that character; but that does not really seem to us to be the question. The question, if we mistake not, is, whether, if the ideas contained in "The Data of Ethics" prevailed in the world, it would be possible to maintain a life-boat service at all; and we should like to ask Mr. Smith whether *he* is sure that it would not. If he is uncertain upon this point, his uncertainty may perhaps balance ours upon the other. Our own opinion, which must pass for what it is worth, is, that it would be quite possible. The foundations of devotion lie very deep in human nature. That poor Caffre mother we were speaking of a moment ago would illustrate it if the need arose. Every nation and every tribe has had its heroes who cheerfully faced death for the common cause; and that without a thought of future reward, or, in a multitude of cases, any definite expectation of continued existence. Describing one of the very worst periods of Roman history, Tacitus is yet able to say, "*Contumax etiam adversus tormenta servorum fides*" (slaves were found who braved even torture for the sake of their masters). Yet these unhappy bondmen had no "village church" to serve as the center of ideas and hopes relating to another sphere of existence. If we may attempt an explanation of the matter in terms of the evolution philosophy, we should say that the course of physical evolution creates in us a strong attachment to life, but that the course of what Mr. Spencer has called super-organic evolution gradually creates for us objects of thought and affection which may become dearer than life

itself. Our hope, therefore, is that, in the society of the future, not only will "the milkman go his rounds"—a point upon which Mr. Smith kindly reassures us, and, after all, one of no little significance—but volunteers for the life-boat, the fire-brigade, and all necessary heroic undertakings, will still be forthcoming. If, when the time arrives, men have ceased to risk their lives, as they now so frequently do, in foolish enterprises, without, so far as one can judge, being particularly incited thereto by ideas or hopes connected with the village church, it will be all the better.

2. Evolutionary ethics can not explain conscience, can not tell us why the bad man is miserable in prosperity, and the good man happy in adversity. Is it really so? What is human character but a complex of mental and moral habits, every habit incorporated into it becoming a more or less imperative voice vibrating through the man's whole nature? To know that you have not dotted an *i* or crossed a *t* will sometimes give you an uncomfortable feeling. Make a rule of anything, and you will not depart from it without uneasiness. How powerful are the habits of the body every one knows, and those of the mind are not less so. The murderer referred to by Mr. Smith is ill at ease because he has allowed a momentary impulse connected with the least authoritative* part of his nature, the mere desire for personal advantage, to carry him into an act of rebellion against a principle of conduct woven into his nature long before he was born, and for which in his subsequent life he has constantly been compelled, not only to profess, but to demand, respect. If it be said that it is impossible to account on this theory for the tone of absolute authority with which conscience urges its decrees, we would ask for a very careful consideration of the passages quoted below from the "Data of Ethics." Mr. Spencer has well shown that, just in proportion as the reasons for doing, or refraining from, a particular act are dissociated from what we may call the ultimate material inducements or deterrents, will the *authority* they possess be greater. When a man eats because he is hungry, he feels the power, but not the authority, of appetite. When, on the other hand, he refrains from a vicious indulgence because its later effects will be bad, or when he takes a walk before breakfast because he believes it will conduce to his health, though its good effects may not be immediately apparent, he recognizes and feels the *authority* of sanitary rules. In these cases the degree of dissociation between the rule or principle recognized by the mind and the actual facts on which it rests is but slight; yet the rise of *authority* is plainly visible.

* Let the reader who needs to do so refresh his memory with the following passages from Spencer, "Data of Ethics," chapter vii—"The Psychological View": "From the first, complication of sentiency has accompanied better and more numerous adjustments of acts to ends. . . . Whence it follows that the acts characterized by the more complex motives and the more involved thoughts have all along been of higher authority for guidance. . . . When, led by his acquisitiveness, the thief takes another man's property,

A rule of conduct once established, the mind, working quite independently of the will of the individual, resents any attempt to impugn its authority. Naturally enough, seeing that, to impugn its authority means an unsettlement of all that the rule had settled. Take the case now in question. We can not conceive the existence of any social order, unless the principle is recognized that no man should, for selfish purposes of his own, take the life of another. But, let a man be so overmastered by his cupidity as to commit this crime, he can not by that one act of rebellion undo the work already accomplished in his mind, by virtue of which he had learned to condemn murder on principle. It is to his interest now to deny the principle, but he can not do it without tearing his own mind to pieces; for not more truly have certain elements been compounded in his body, to form its various organic substances, than have elementary experiences combined in his mind to form those principles of thought which sustain its functional activity and make it a living organism. And just as the true unit of the body is not any elementary atom, but a cell, so the true unit of the mind is not an isolated experience, or any cluster of unorganized experiences, but a combination of experiences, a generalization from experiences.

The murderer in the case supposed by Mr. Smith has eluded the law, and not only paid no material penalty whatever, but actually reaped vast benefits from his crime. Could any case be possibly imagined in which—making, of course, allowance for the inferiority of nature of a man who could commit murder at all—the violated authority of perhaps the most fundamental of all social principles should make itself more keenly felt? Had the man been caught red-handed, and come promptly under the sentence of justice, his remorse would have been slight in all probability; possibly he might not have felt any. But, escaping as he did, and prospering by his crime, his mind would remain continually open to the upbraidings of that part of his nature which he had outraged by his deed, to all the *reasons* which the experiences of every day as well as his involuntary thoughts would suggest why the deed should not have been done. Is not this enough? Must we still call in the Eumenides before

his act is determined by certain imagined proximate pleasures of relatively simple kinds, rather than by less clearly-imagined possible pains that are more remote and of relatively involved kinds. . . . Throughout the ascent from low creatures up to man, and from the lowest types of man up to the highest, self-preservation has been increased by the subordination of simple excitations to compound excitations—the subjection of immediate sensations to the ideas of sensations to come—the overruling of presentative feelings by representative feelings, and of representative feelings by *re*-representative feelings. As life has advanced, the accompanying sentiency has become increasingly ideal; and, among feelings produced by the compounding of ideas, the highest, and those which have evolved latest, are the re-compounded or doubly ideal. Hence it follows that as guides the feelings have authorities proportionate to the degrees in which they are removed by their complexity and ideality from simple sensations and appetites."

we can understand why the murderer should be wretched amid his wealth?

We must not, however, forget that Mr. Smith supposes the murderer to be able to flatter himself that he has probably caused more happiness than unhappiness by his crime. Such a supposition might perhaps embarrass a utilitarian of the old school, but hardly an adherent of the "rational utilitarianism" taught by Mr. Spencer. Crude utilitarianism assumes that an action can only be judged by the consequences which directly and visibly flow from it; rational utilitarianism says that the criterion of an action is some rule of conduct established by experience. The crude utilitarian is like a man who would discard or ignore the multiplication-table, and insist on doing all sums involving multiplication by addition; or who should insist on working out, by tedious and uncertain arithmetical processes, problems which could be solved with the far greater ease and certainly by algebra. Experience shows what *lines* of conduct, what *principles* of action, are favorable to happiness in general, and to the satisfaction of the instinct of sympathy in particular; and human civilization can not be carried very far before the principle is established that harm must come from the shedding of human blood. Such a principle gains *authority* over men's minds; and, when an action is done that conflicts with it, it is in vain that the perpetrator tries, by a fresh calculation of all the supposed elements of the case, to show that his particular crime may be all right.

3. We are probably now prepared to estimate the force of the next objection urged by Mr. Smith against evolutionary ethics, that they do away with the idea of the "indefeasible sacredness of human life." They would no doubt do away with any surplusage of mere sentiment on the subject; but, seeing that the first moral principle which emerges, from the evolutionary point of view, is equity, and seeing that life is what every man holds most dear, it is very hard to understand why a system, which may be said simply to rationalize the Golden Rule, should lead men to deal less carefully with human life than the systems of the past. What light does history shed upon the question? In what estimation was human life or human suffering held in the ages of faith? It was surely in a pre-evolution period that a man could be hanged in England for stealing a sheep. Such things can not be done to-day. Why? Is it—we should like a candid answer to the question—because there is a deeper impression than formerly that man is made in the image of God; or because the sentiment of justice has grown stronger, and men have learned to sympathize more with one another?

4. Finally, we are told that Mr. Spencer, being an evolutionist, must be a necessarian, and that, as such, it is not open to him to condemn any act as wrong, seeing that the doer of the act could plead that his conduct was just what the point he had reached in evolution ren-

dered natural and necessary. Mr. Spencer is undoubtedly an evolutionist, but we do not know that there is any distinct warrant for saying he is a necessarian. We do not know that he is more embarrassed by the secular antithesis of free-will and necessity than others have been before him, or are now. Were necessarianism a corollary from evolution, it would be in order to remark that it has also been, with a not uninfluential school of Christian thinkers, a corollary of the conception of the divine nature. Mr. Smith, we observe, records his own objection to the term "free-will"; remarking that what has inappropriately passed under that name should rather be defined as "the difference given us by consciousness between moral and physical causation. He thus recognizes moral causation; and his objection to the expression "free-will" would seem to be grounded on its implied denial of such causation. Mr. Spencer, on his side, objects to the free-will theory because it denies the "cohesions" which demonstrably exist between psychical states. Is it certain that between the two views so great a gulf is fixed that Mr. Smith can afford to snap his fingers in happy security, while contemplating the speculative torments of the author of "The Data of Ethics"? Seeing, however, that this is a difficulty with which human thought has never been able to grapple successfully, it might be as well to raise no question concerning it. The evolutionist condemns a wrong action on this ground, that it conflicts with some principle of proved utility, or of proved equity—the two are really one—which, if not as potent so might be desired, still has its place in the mind of the man who has neglected or overridden it. We condemn moral inconsistency just as we do intellectual inconsistency. When a man puts forward an opinion we regard as false, our only hope of persuading him that it is false is by bringing into the strongest possible relief some truth or opinion, *accepted by him*, with which the opinion in question conflicts. Precisely parallel is the procedure when a man performs an act of which we disapprove: we call some ethical principle accepted by himself, and acted upon at times by himself, to bear witness against what he has done. By doing so we re-enforce the higher principle, and perhaps bring about shame and repentance for the improper act.

We have thus tried to deal with the chief objections formulated by Mr. Smith against the evolutionary theory of morals. To speak of that theory as a purely "physical" one (as Mr. Smith does) is hardly correct. Mind, according to Mr. Spencer, is made up of feelings and relations among feelings, and these are not properly physical. Memory and judgment may have a physical basis, but they are not themselves physical. The evolution of conduct, according to Mr. Spencer, depends wholly upon accretions of capital, so to speak, in consciousness. A dim and narrow consciousness renders possible only a most imperfect self-direction; a clear and highly developed consciousness, on the other hand, gives a correspondingly increased power of self-direction, which is used in the furtherance of life and happiness. There is a school of French philosophers to-day * who, while making frank profession of atheism, speak of man as the union of an organism with an "immateriality." The language is uncouth ; but it might be used, at least provisionally, to express Mr. Spencer's conception ; for, while the whole direction of every human being proceeds from his consciousness, that consciousness is not itself material or physical, the very essence of materiality being objectivity to sense. From the evolutionary point of view every mite of moral effort is just as precious as from the theological point of view ; but what the evolutionary theory does not do is to reconcile us to the miseries that have abounded and still abound in the world, as possibly having their explanation and justification in some supernatural scheme of government. If the sufferings borne by our fellow-creatures are any part of the Divine scheme, as Mr. Smith hints may perhaps be the case, what confidence can we feel that we are right in trying to alleviate them ? With a strange inconsistency, the partisans of a supernatural view of disease are always ready to apply themselves most vigorously to abbreviating by natural means the chastisements which they say are meant for their good ; while the more sensible among them manage, by a careful attention to the rules of health, to escape such chastisements altogether, or nearly so. And so we have no doubt it would be if Mr. Smith had it in his power to greatly ameliorate the general lot of mankind : he would do it, and let the moral education of the race take its chance under the happier conditions.

Evolutionary ethics tell us what is evil, and explain the why. They tell us that whatever depresses the energies of any human being, or comes between labor and its due reward, is evil. It drops no hints of mysterious compensation hereafter for ills borne in this life—so making things a trifle more comfortable still for the "man in the suburban villa, with a good business in the city," whom the voice of duty so imperiously calls to take a regular luncheon every day, instead of merely swallowing a hasty sandwich. That worthy citizen might, in the interest of his digestion, like to think that the shivering, storm-tossed mariner, the delver in the mine, the overworked and underfed farm-laborer, and all the beaten and baffled and despairing ones whose lot is so disagreeable a contrast to his own, should some day, after they had served their turn here in the production of capital, have some modicum of compensating happiness dealt out to them in a better world. If such be his soothing fancy, he can not at least profess to draw it from the doctrine of evolution, which proclaims, without reserve or qualification, that suffering is suffering, that injustice is injustice, and that, if we would remedy these, we must work while it is called day. It is the weakness not the strength of theological and ultra-mundane doctrines

* The so-called "Socialistes Rationnels," whose organ, "La Philosophie de l'Avenir," contains some acute and powerful writing.

that they lead, and have led, men to regard with more or less of acquiescence the sufferings of "this present evil time." That there may be a Providence inwrapping the whole of human life with its environment, and that there may be, to higher faculties than ours, a significance in life that we have never grasped, it would be most adventurous and, indeed, unphilosophical to deny. Admitting such a possibility, however, or even probability, our duty is in no way changed. The whole solar system may be hurrying on through space toward some unknown goal, or in some infinite and incalculable circuit; but the motions that concern us are those that take place within the solar system, that lend themselves to observation and calculation, and that affect more or less the conditions of human life. We live in an environment to which we are adapted: absolute truth lies beyond us, but relative truth is within our grasp. The poet says that "things are not what they seem," but things *are* (to us) what they seem. What else can they be? And it is our duty to deal with them as we find them, with a constant view to the realizing of higher and higher harmonies in life. Some notes we have already attuned, but there are discords yet, many and harsh, to be subdued. Then let us set our faces steadfastly forward, not to "confront a void," for there is no void to confront—nothing has fallen out of the universe that ever was in it—but with a determination to conquer more and more of moral freedom, and, by our conscious efforts, to aid that unconscious labor of the ages by which better and better conditions are ever being won for the human race.

TIME-KEEPING IN LONDON.

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I.

IT is proposed in this paper to describe some special features of the instruments by which time is kept at the Royal Observatory, Greenwich, the means for correcting them, and the methods and instruments by which time-signals are distributed from the observatory to London and elsewhere.

The primary standard time-keeper of England is a sidereal clock kept in the basement of the Royal Observatory, Greenwich. This clock is of the best construction, and is, moreover, provided with the most approved apparatus for compensation and correction.

Experience has shown that the best results are obtained when the connection between the driving-weight and the pendulum of a clock is as slight as possible. This has been accomplished in the Greenwich clock by the use of an elegant escapement, the details of which are shown in Fig. 1,* representing a back view of the clock-train. The crutch-axis, supported by the arm (*c*) and the back plate (*b*) of the clock-train, carries an arm (*e*), attached at *f* to the left-hand pallet arm. The pallets are carried by the crutch-rod (*d*). At *g* is attached a detent projecting toward the left and ending in a light curved

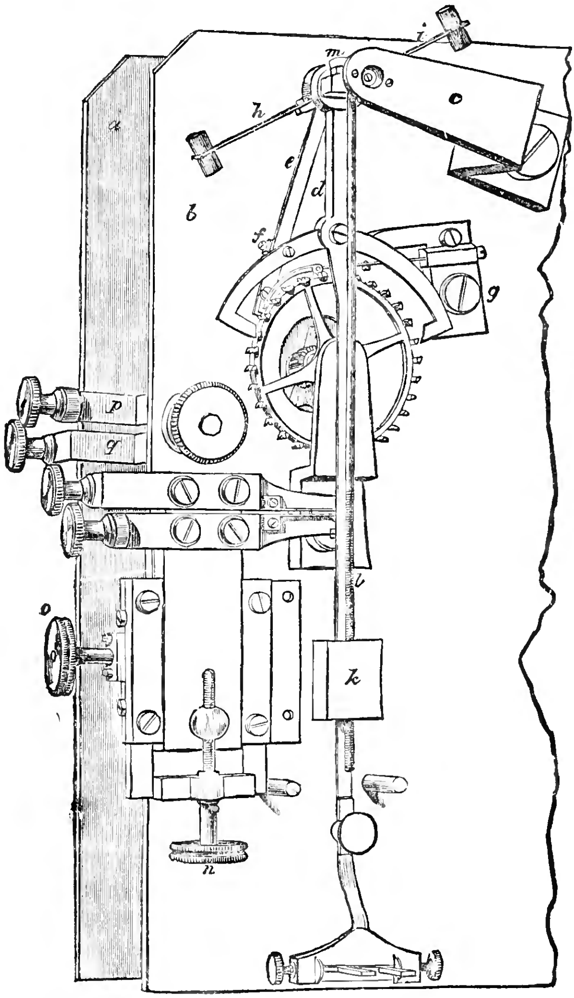

Fig. 1.—Greenwich Clock Escapement.

spring. Near the top of the escape-wheel this detent carries a jeweled pin which locks the wheel. The action is as follows: When the pendulum swings toward the left, the arm (*e*) lifts the delicate spring at the end of the detent, the wheel is released and drops forward so that a tooth presses against the face of the pallet and gives an im-

* Figs. 1, 3, 4, 5, and 6, have been taken from Lockyer's "Stargazing," through the courtesy of Macmillan & Co., London, publishers, by permission of the author.

pulse to the pendulum; the spring at the end of the detent immediately locks the wheel again, and the pendulum swings on freely to the left. When the pendulum swings to the right, the light spring at the end of the detent lets it pass without unlocking the wheel. The right-hand pallet is only intended to catch the wheel in case of accident and forms no essential part of the escapement. Thus, it will be seen, the pendulum is quite free except during a part of every alternate second, when it releases the escapement and receives an impulse; the seconds-hand, attached to the escape-wheel, moves only once every two seconds.

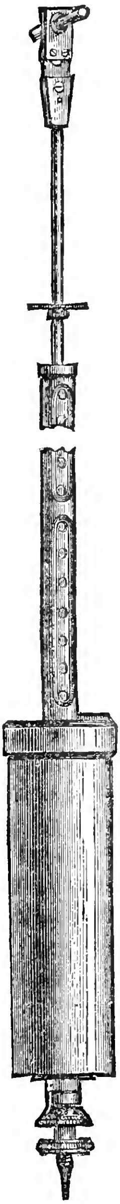

Fig. 2.—Greenwich Pendulum. Elevation.

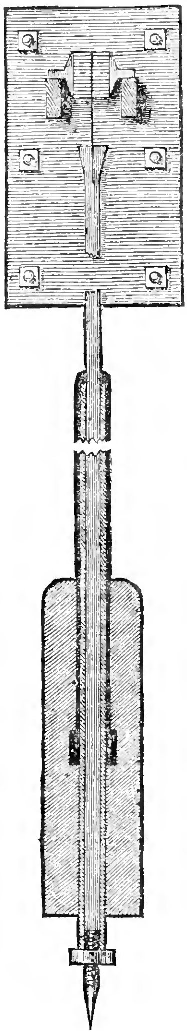

Fig. 3.—Greenwich Pendulum. Section.

The most important source of error in the running of a fine clock is the change in the length of the pendulum due to change of temperature. Two methods suggest themselves of eliminating this error: 1. To put the clock where it will not be subject to changes of temperature. 2. To counteract the effect of changes of temperature. To this end various kinds of pendulums have been devised, notably the mercurial and gridiron forms, which are known under the general name of "compensating pendulums." At Greenwich the two methods are combined to insure complete success. The clock is placed in the magnetic basement of the observatory, where the temperature is as nearly uniform as possible, and apparatus is provided to annul the effect of any change of temperature which might occur.

Tests made with a mercurial pendulum disclosed the fact that the steel rod responded more quickly than the mercury to a change of temperature, and that consequently an appreciable interval of time was required for perfect compensation; a modification of the gridiron form, shown in Fig. 2, was therefore adopted. The pendulum was designed by Messrs. E. Dent & Co., of London, for the Transit of Venus Expedition (1874), but has since been used for the primary standard time-keeper of the United Kingdom. Its construction will be best understood by reference to the section shown in Fig. 3. To the lower end of a steel rod, suspended in the ordinary manner, is attached the screw for rating the pendulum. On this screw and surrounding the rod rests a zinc tube, extending upward; inclosing the zinc tube and attached to its top is a steel tube extending downward; on a collar, at the lower end of the steel tube, hangs the cylindrical leaden bob, attached at its center. Slots and holes are cut in the tubes in order to equally expose all parts. The following table, taken from the official records of the Royal Observatory, is published by Messrs. E. Dent & Co., for the purpose of showing the performance of a clock with steel and zinc pendulum:

CLOCK—DENT 1914.

DATE.				Clock slow of Greenwich sidereal time.		Mean daily losing rate during each interval.	Average temperature of external air.
		Days.	Hours.	Minutes.	Seconds.	Seconds.	
1871—	September	3	21	14	31·8	..	..
		17	21	15	34·1	4·4	62°
		24	21	16	2·3	4·0	54
	October	1	22	16	34·2	4·5	50
		8	21	17	5·1	4·4	52
		15	21	17	36·9	4·5	46
		22	21	18	8·2	4·5	54
		29	21	18	37·8	4·2	47
	November	5	22	19	7·8	4·3	47
		12	22	19	36·2	4·1	39
		19	21	20	5·8	4·3	35
		26	22	20	36·3	4·3	34
	December	3	21	21	6·7	4·4	36
		10	22	21	33·9	3·9	30
		17	21	22	6·6	4·7	40
		26	0	22	45·2	4·8	42
		31	22	23	13·2	4·7	43
1872—	January	7	22	23	46·3	4·8	42
		14	21	24	20·7	4·9	40
		21	21	24	54·2	4·8	39
		28	22	25	30·2	5.1	42
	February	4	22	26	6·4	5·2	44
		11	22	26	41·4	5·0	47
		18	21	27	16·0	5·0	44
		25	22	27	50·0	4·8	45
	March	3	21	28	24·1	4·9	46
		10	22	28	58·1	4·5	49
		17	21	29	31·2	4·8	45

During the whole time of rating, the clock was situated in a small hut erected for observing the Transit of Venus. No record of the temperature of the hut was kept, but the variations would be very similar to those of the external air, whose average temperature for each interval is given in the table.

The compensating action of the pendulum evidently depends upon the relative lengths of steel and zinc, and it is easily possible that great difficulty would be experienced in cutting and fitting tubes of exactly the right length; to complete the adjustment a very delicate contrivance is added.

Two compound bars of brass and steel (*h* and *i*, Fig. 1), with small weights at their ends, are hung to the crutch-axis by means of a collar loose enough to be easily turned. The rods are so made that under normal conditions the brass and steel are of the same length, and the two bars are in the same straight line; the center of gravity of the rods and the weights (regarded as one body) is therefore in the axis, and the weights are balanced in every position, no matter what angle the line of the rods makes with the plane of the horizon; they affect the pendulum only by their inertia. But, when a change in temperature occurs, the brass and steel become of unequal length, owing to a difference in the co-efficients of expansion of the two metals, the rods are bent, and the center of gravity of the rods and weights is no longer in the axis, nor is it in the same vertical plane as the axis except when the weights are in a horizontal line; so that an unbalanced force is introduced whose compensating action varies from a maximum when the weights are in a horizontal line, to zero when the weights are in a vertical line. To be explicit, suppose the rods to be horizontal and the brass uppermost, and let there be an increase of temperature. The brass will expand more than the steel, and, the rods being bent downward, the weights will be lowered. As the pendulum swings the weights swing with it, and are continually trying to get back to a horizontal position where they would balance each other; if they were swinging alone, they would evidently swing faster than the pendulum, and therefore, being attached, they accelerate its motion. If the steel were uppermost, the weights would be raised with an increase of temperature and the pendulum retarded. If the rods were both vertical, a change of temperature would only throw the center of gravity of the two weights to one side or the other of the axis, but would not raise or lower it; this would only introduce a continuous force tending to make the pendulum oscillate farther on one side than the other, but not affecting its rate. At intermediate positions between the vertical and horizontal, the change in the position of the center of gravity due to a change of temperature would vary with the angle made by the line joining the centers of gravity of the two weights with the plane of the horizon; any required compensating action, between the limits above mentioned, for a known change of temperature, can therefore be obtained by setting the rods at the proper angle.

In order to make a small change in the rate without stopping the pendulum, the device shown in Fig. 1 has been employed: A weight (*k*) slides freely on the crutch-rod shown back of it in the figure, but is held by the screw on the end of the spindle (*l*) which hangs from the nut (*m*) at the crutch-axis. By turning the nut (*m*) the weight (*k*) can be lowered or raised, and this makes the clock gain or lose.

But the nicety of the correction of variations due to changes of temperature has brought to light variations due to another cause commonly quite overlooked ; it has been found that the pendulum is affected by changes of barometric pressure. A change in the barometer of an inch and a half will sensibly alter the rate of the pendulum. The difficulty might be avoided by placing the clock in a vacuum, but this is evidently impracticable. In the Greenwich clock the method shown in Fig. 4 has been adopted to counteract the effects

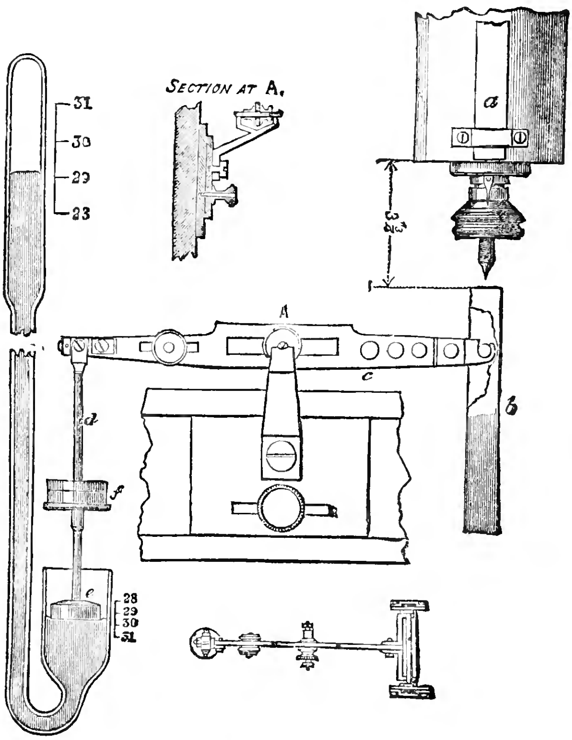

FIG. 4.—GREENWICH CLOCK : ARRANGEMENT FOR COMPENSATION FOR BAROMETRIC PRESSURE.

of barometric changes. To the pendulum-bob are attached two vertical bar-magnets, one in front (*a*) with the north pole down, the other at the back (and therefore not shown in the figure), with the south pole down. Below these and normally at a distance of $3\frac{3}{4}$ inches from them is a horseshoe magnet (*b*) which hangs on one end of a lever (*c*) nicely balanced on knife-edges at A ; the other end of the lever (*c*) rests by means of a rod (*d*) on a float (*e*) in the shorter leg of a siphon barometer. Counterpoises are added at *f* to balance the magnet (*b*). A plan of the lever on a smaller scale and a section at A are also shown in the figure. The barometer-tube is made so much larger in the shorter than in the longer leg that a change of one inch in the barometer would move the float in the shorter leg only two tenths of an inch. A rise or fall in the barometer causes a corresponding motion in the horseshoe magnet, and thus varies the intensity of its attraction for the magnets on the pendulum-bob. By proper adjustment this varying attraction is made to furnish the required compensation.

The small error which remains, notwithstanding the above-detailed provisions for correction, is allowed to accumulate, but is determined daily (unless clouds prevent) by transit observations,* so that the exact sidereal time is always known.

The standard sidereal clock registers its beats upon the chronograph record; controls, by electric connection, all the sidereal clocks in the different rooms of the observatory; and drives a sidereal chronometer (*b*, Fig. 5), in agreement with itself, in the computing and time-distributing room.

The secondary regulator of the time of England is the mean solar standard clock at the Royal Observatory, which was specially erected in 1852 for service in the time-signal system, of which it is now the most important instrument. This clock has a seconds-pendulum, which closes an electric circuit as it swings to the right. An electro-magnet in the circuit lifts a small weight, which is discharged upon the pendulum as it swings to the left, and gives it an impulse; this being repeated at each vibration is sufficient to keep it in motion. The pendulum also closes other galvanic circuits—one as it swings to the right, another as it swings to the left—which send currents alternately positive and negative through electro-magnets, alternately attracting and repelling bar-magnets fastened to an axis, which thus receives a reciprocating motion. An arm projecting from this axis moves the seconds-wheel one tooth forward each second; proper gearing gives motion to the minute and hour wheels.

The mean solar standard, besides controlling other clocks, to be enumerated later, drives a seconds-relay (*a*, Fig. 5), which controls a mean-time chronometer (*c*).

All the clocks controlled by the mean solar standard are required to indicate exact Greenwich local time; the error can not therefore be allowed to accumulate, and the means of correction are provided. Carried by an arm projecting from the pendulum-rod of the mean solar standard is a magnet, five inches long, which swings just over a

* The difference between the clock-time of the transit of a star over the meridian (corrected for errors of position of the instrument, and for "personal equation") and the right ascension of the star for the day, taken from the nautical almanac, is the error of the clock.

hollow galvanic coil, called "the accelerating or retarding coil," fastened to the clock-case and operated by a special battery. The attraction or repulsion, between the magnet and the coil, produced by sending currents in opposite directions, gives any required acceleration or

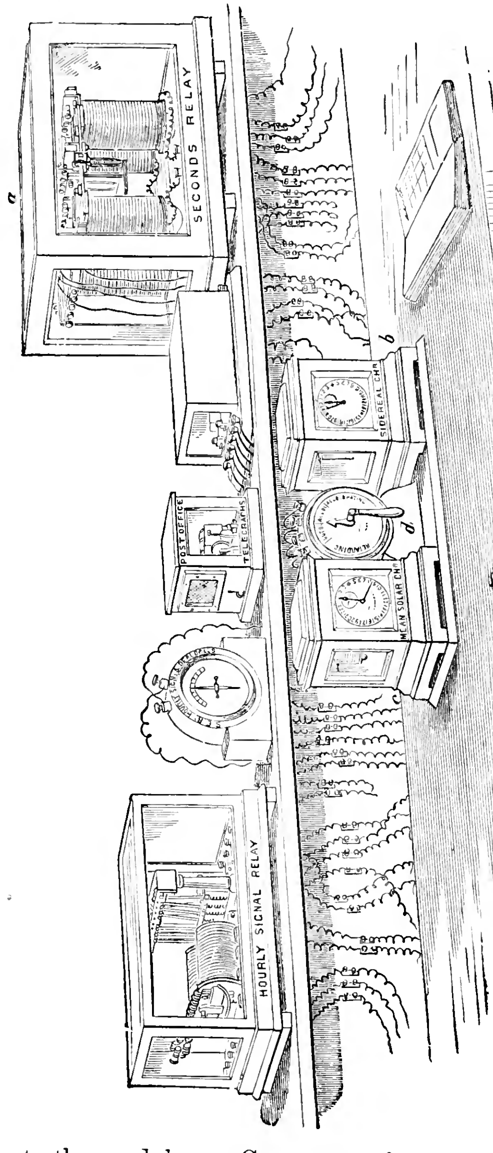

FIG. 5.—ARRANGEMENT FOR CORRECTING MEAN SOLAR STANDARD CLOCK AT GREENWICH.

retardation to the pendulum. Care must, of course, be taken that the correction be not made too quickly, else the clock, instead of being controlled by the current, will break away from control, and the error will be increased. It is now so arranged that the current will produce a correction of one second in about ten seconds. The correction is made as follows: Between the sidereal chronometer (*b*, Fig. 5) and the mean-time chronometer (*c*) there is a commutator (*d*). By moving its handle toward the right, a current is sent through the "accelerating or retarding coil" which accelerates the mean solar standard; by moving the handle toward the left, the current goes through the coil in the opposite direction, and retards the mean solar standard; in the intermediate position (shown in the figure) no action takes place. The operator, having ascertained the error of the sidereal standard and its sympathetic chronometer, by astronomical observation as described, applies this error to the face-reading of the sidereal chronometer, and gets the exact sidereal time; by simple reduction he finds the corresponding mean solar time, and, by comparison, the error of the mean-time chronometer; he then moves the handle of the commutator, and corrects the error of the mean solar standard, and of all the clocks controlled by it, without leaving his position in the computing-room. This correction can be made at any instant when the exact time is desired; it is usually made at 10 A. M. and 1 P. M., because at those hours a general distribution of time-signals takes place.

The mean solar standard serves for the distribution of accurate time in the following ways:

Nearly all the mean-time clocks in the Royal Observatory are driven by the standard clock; they are, in fact, simply dials whose hands are moved in the same way and by the same battery as the hands of the standard itself. These clocks are placed in the various rooms of the observatory, so that the astronomers have the exact time close to any of their instruments. One of them is in the wall surrounding the grounds, and will be familiar to every one who has visited the observatory; several are placed in the chronometer-room, where the navy and other chronometers are corrected and regulated.

The seconds-relay (*a*, Fig. 5), already referred to, is also driven by the mean solar standard.

Until 1880 the standard clock controlled, by seconds-beats, a number of clocks on a private wire in London, which were made to beat synchronously with the standard by an application of the Jones system,* in which the electric current is used, not as a driver, but as a regulator of clocks already running with small error and by means of their own motive powers. This plan, though still used within the observatory, has been abandoned in London.

With the standard clock is connected another electric circuit, open in two places. These are both automatically closed by the clock, one at the end of each minute, but the other only for some seconds on either side of the end of each hour; so that they are both closed only at the end of each hour, and then only can the current pass.

* For an illustration of the Jones system for regulating clocks at a distance, see article on "Time-keeping in Paris," "Popular Science Monthly," January, 1882.

This hourly current acts on the magnet which drops the Greenwich time-ball daily at one o'clock, and on the magnet of the hourly relay (to the left in Fig. 5) which completes several independent circuits, each controlling a separate line of wire. One of these extends to the central telegraph station at the General Post-Office in London, and another to the London Bridge Station of the Southeastern Railway. The bell and galvanometer marked in Fig. 5 "P. O. Telegraphs" and "S. E. R. Hourly Signal and Deal Ball" show the passage of these currents.

Thus far the service is under the control of the astronomer royal, and he holds himself responsible to send the signals described along each line every hour of the day and night with the greatest attainable accuracy. The signals are generally correct within one tenth of a second of error. Should, however, by any accident, an hourly signal be in error, even to half a second, another signal is immediately sent, announcing that the last was not reliable. Special pains are then taken that the next hourly signal be correct. Here the responsibility of the astronomer royal (except for the dropping of the Deal ball, to be explained later) ends.

On the other hand, it is to be remarked that the Post-Office Department, which undertakes the distribution of these signals to London and the country, agrees to furnish subscribers, not with correct signals, but with the signals which they receive from Greenwich. The Greenwich signals, however, being considered everywhere in England as absolutely correct, constitute a standard from which there is no appeal.

[*To be continued.*]

THE RELATIONS OF THE NATURAL SCIENCES.*

By T. STERRY HUNT, LL. D. (Cantab.), F. R. S.

THE occasion which brings us together is one which should mark a new departure in the intellectual history of Canada. Science and letters find but few votaries in a country like this, where the best energies of its thinkers are necessarily directed to devising means of subduing the wilderness, opening the ways of communication, improving agriculture, building up industries, and establishing upon a proper basis schools in which the youth of the country may be instructed in those arts and professions which are among the first needs of civilized society. The teachers, under such conditions, can do little

* The President's Address before the Mathematical, Physical, and Chemical Section of the Royal Society of Canada, at the first meeting of the society, Ottawa, May 27, 1882. Reprinted, with an added note, from the "Canadian Naturalist," vol. x, No. 5.

more than interpret to their pupils so much of the wisdom of the past, and of contemporary science, as may suffice for the immediate wants of the country, and will have but scanty leisure for original investigation in the field of knowledge. There are, however, never wanting earnest and curious minds who feel an almost irresistible impulse to labor in this field, to enlarge the bounds of thought, and to grapple with the great problems of man and nature. To foster this spirit, to encourage its beginnings, and to extend the influence of its example, should be the aim of wise statesmen and legislators who seek to elevate their kind and ennoble their nation ; knowing that the brightest glories and the most enduring honors of a country are those which come from its thinkers and its scholars.

The world's intellectual workers are, from the very nature of their lives of thought and study, separated in some degree from the mass of mankind. They feel, however, not less than others, the need of human sympathy and co-operation, and out of this need have grown academies and learned societies devoted to the cultivation of letters and of science. The records of these bodies in Florence, in Rome, in Paris, in London, and elsewhere, are the records of scientific progress for the last three centuries. Such bodies do not create thinkers and workers, but they give to them a scientific home, a center of influence, and the means of making known to the world the results of their labors.

It was with a wise forethought that more than a century since Franklin and his friends founded at Philadelphia the American Philosophical Society. Its planting then seemed premature, but its vigorous growth during a century has served to show that the seed was not too early sown. This, however, unlike many of the academies of the Old World to which we have adverted, had no formal recognition from the State, and there came a period in the growth of the American Union when the need of an official scientific body was felt. Thus it was that nineteen years ago, in the midst of the great civil war, the American Congress authorized the erection of a National Academy of Sciences, to which, as an American citizen, I have the honor to belong. The aim proposed in founding this Academy was to gather together what was best and highest in the scientific life of the nation, and, moreover, to organize a body of councilors to which the executive authority could always look for advice and direction in scientific matters relating to the interests of the State. In this National Academy—at first consisting of fifty, and now practically limited to one hundred members (a number which it has not yet attained)—the domain of letters is unrepresented ; while the Royal Society of London is, in like manner—although scholars and statesmen seek the honors of its fellowship—essentially an Academy of Sciences.

Our infant organization attempts a larger plan, and embraces, with the mathematical and physical sciences, letters, philosophy, and history, imitating the Royal Irish Academy, which, like this, is divided into two classes; that of the Sciences, on the one hand, and that of Polite Literature and Antiquities on the other. The Institute of France, made up of five Academies, embraces the Fine Arts in its still wider scheme. The second class of our society, with its two sections, aspires to cover the same ground as the Academy of Sciences of the Institute of France, the Science division of the Royal Irish Academy, the Royal Society of London, and the National Academy of Sciences of the United States.

The two sections into which our second class is now divided—namely, III, including Mathematic, Physic, and Chemistry, and IV, embracing Biology and Geology—are, in their aims and their objects, closely related to each other, and widely separated from Sections I and II, which are devoted respectively to French and English Literature and History. Differences in language thus establish in the literary department of this society a natural division into two sections. In the department of the sciences, however, there is no natural basis for a similar division, and it will probably be found in the near future that subjects of common interest will draw more and more closely together our two sections until, as in the various societies which we have named, the distinction between mathematical, physical, and chemical studies on the one hand, and geological and biological studies on the other, will be lost sight of. It seems to me therefore fitting that we should consider the mutual relations of these two divisions, and inquire into the value of the distinctions upon which they have been based.

Apart from pure mathematic, which is based upon our intuitions of space, the sciences which now concern us have to do with material nature, and are properly called natural sciences. It is not their province to look behind or beyond the material world of nature, nor to grapple with the mystery of the Infinite, with which, in the last analysis, the inquirer always finds himself face to face. Our various metaphysical systems are schemes which men have devised to solve this mighty problem, and to translate into intelligible language their efforts to comprehend it. What we call Nature is at once a mantle and a veil in which the spiritual both clothes and conceals itself. "I weave," Goethe makes the world-spirit say, "the living garment of the Deity." This phrase embodies a profound truth. All nature is living; it is, as the word *natura* itself, equally with its Greek equivalent, *physis*, implies, that which is growing, the perpetually-becoming or being born; and this sense, which underlies etymologically the words *natural* and *physical*, should never be lost sight of.

It is a common reproach in the mouths of certain cavilers at science that it does not explain the beginnings of life in matter. That the plant and the animal are living, is evident to them, but they assume that the air, the water, and the earth, the elements from which the plant grows and is fed, are dead; that life is a mysterious something which comes from without, and is extraneous to the organism. Perhaps we may trace the origin of this conception to the ancient legend, which appears in more than one form, of a human body fashioned out of dead matter and waiting for vivifying breath or fire. The student of inorganic nature, however, soon learns to recognize the fact that all matter is instinct with activities, and finds that a great number of those processes which were formerly regarded as functions of organized bodies are really common to these and to inorganic matter. The phenomena of gravitation, of light, and of electricity, the diffusion and transpiration of gases and liquids, the crystallogenic process, and the peculiar relations of colloids, are all, when rightly understood, manifestations of energies and activities which forbid us to speak of matter as dead. To all of these dynamical (or, as they are generally called, physical) activities of matter, supervene those processes which we name chemical, and which give rise to new and specifically distinct inorganic forms. The attaining of individuality by matter, which has always seemed to me the greatest step in the progress of nature, is first seen in the crystal, but therein the forces of matter are in a statical condition, except so far as certain dynamical relations are concerned. It is not until solid matter rises from the crystalline to the higher condition of the colloid, that it becomes capable of absorption, diffusion, and even of assimilation; that, in a word, it assumes relations to the external world which show that it possesses an individuality higher than the cyrstal, and is, in fact, endowed with many of the activities belonging to those masses of colloidal matter which biologists have agreed to call living.

In these phenomena we have the first developments of individuality and of organization, and I think that the careful student who endeavors with a strong mental grasp to seize the true relations of things will see that we have here to do, not with a new activity from without, but with a new and higher development of a force which is inherent in matter, and thus manifests itself at a certain stage in chemical development. He will then, in the words of a philosophic poet—

"See through this air, this ocean, and this earth,
All matter quick, and bursting into birth."

The adjective, *quick*, is here to be understood in its primitive sense of living, as opposed to dead, and aptly defines the notion which I have endeavored to convey. All the energies seen in nature are in this view but manifestations of the essential life or quickness of matter, whether displayed in the domain of what are called dynamical or physical activities, in chemical processes, or in the phenomena of irritability, assimilation, growth, and reproduction, which we may comprehensively designate as biotical.*

* This view, upon which I have insisted in the essay on "The Domain of Physiology," cited below, was well set forth by Rosmini. According to him, in the words of his in-

When we have attained to this conception of hylozoism, of a living material universe, the mystery of Nature is solved. The cosmos is not, as some would have it, a vast machine wound up and set in motion with the certainty that it will run down like a clock, and arrive at a period of stagnation and death. The modern theory of thermodynamic, though perhaps true within its limitations, has not yet grasped the problem of the universe. The force that originated and impelled sustains, and is the Divine Spirit which

> "Lives through all life, extends through all extent,
> Spreads undivided, operates unspent."

The law of birth, growth, and decay, of endless change and perpetual renewal, is everywhere seen working throughout the cosmos, in nebula, in world and in sun, as in rock, in herb, and in man; all of which are but passing phases in the endless circulation of the universe, in that perpetual new birth which we call Nature. This, it will be said, is the poet's view of the external world, but it is at the same time the one which seems to me to be forced upon us as the highest generalization of modern science.

The study of nature in its details presents itself to the mind in a twofold aspect—as historical and as philosophical. The first of these gives rise to a General Physiography or description of nature, which we commonly call Natural History as applied to each of the three great divisions designated as the mineral, vegetable, and animal kingdoms. This physiographic method of study in the latter two gives us systematic and descriptive botany and zoölogy, with their classification and their terminology; while the physiography of the mineral kingdom includes not only systematic and descriptive mineralogy as generally understood, but those branches of geology which we designate as petrography and geognosy, or the study of the constituents of the earth's crust, of their aggregation and their distribution.

terpreter, Davidson, "the ultimate atoms of matter are animate; each atom having united with it, and forming its unity or atomicity, a sensitive principle. When atoms chemically combine, their sensitive principles become one. . . . The unit of natural existence is neither force nor matter, but sentience, and through this all the material and dynamic phenomena of nature may be explained." From the unifications of these sensitive principles, or elementary souls, which take place in the combinations of matter, higher and higher manifestations of sentience appear, constituting the various activities displayed in crystals, in plants, and in animals. From these elementary souls organic souls are built up, and "when these are redissolved into the elementary ones through the dissolution of the organized bodies, the existence of the souls does not cease, but is merely transformed." (See "The Philosophical System of Rosmini," by Thomas Davidson, pp. 284–301.) This volume was unpublished, and these views of Rosmini were unknown to me, at the time of writing the above pages.

The eminent biophysiologist, William B. Carpenter, in an essay on "Life," published in 1847, contends that organization and biotical functions arise from the natural operation of forces inherent in elemental matter.—(Todd's "Cyclopædia of Anatomy and Physiology," vol. iii, p. 151.)

The second aspect of the study of nature, which we have designated as philosophical, regards the logic of nature, or what the older writers spoke of as General Physiology. This is sometimes appropriately termed Natural Philosophy, a designation which is the correlative of Natural History. With this method of study in the organic kingdoms we are familiar under the names of physiological botany and physiological zoölogy, which concern themselves with anatomy, organography, and morphology, and with the processes of growth, nutrition, and decay in organized existences. The natural philosophy of the inorganic world investigates the motions and the energies of the heavenly bodies, and then, coming down to our planet, considers all the phenomena which come under the head of dynamic or physic, as well as those of chemistry. These various activities together "constitute the secular life of our planet. They are the geogenic agencies which in the course of ages have molded the mineral mass of the earth, and from primeval chaos have evolved its present order, formed its various rocks, filled the veins in its crust with metals, ores, gems, and spars, and determined the composition of its waters and its atmosphere. They still regulate alike the terrestrial, the oceanic, and the aërial circulation, and preside over the constant change and decay by which the surface of the earth is incessantly renewed and the conditions necessary to organic life are maintained." * Thus the physiological study of the inorganic world, or in other words its natural philosophy, includes in its scope at once theoretical astronomy and theoretical geology or geogeny.

The twofold division which has been adopted in the scientific class of our new society does not correspond to that which we have just set forth, namely, of Natural History on the one hand and Natural Philosophy on the other; nor yet, as might at first seem to be the case, to the more familiar distinction between inorganic and organic nature. Our Section III has been made to embrace, it is true, much both of the natural history and the natural philosophy of the inorganic world, including, besides physic and chemistry, both descriptive and theoretical astronomy and mineralogy. This same section has also been made to include mathematic, which in itself does not belong to the domain of natural science, though in its applications it becomes an indispensable instrument in the study of nature; whether we investigate the phenomena of physic or of chemistry, or seek to comprehend the laws which regulate alike the order of the celestial spheres, the shapes of crystals, and the forms of vegetation.

Section IV, on the other hand, in its department of biology, includes alike the natural history and the natural philosophy of the vegetable and the animal kingdoms. In this same section has, how-

* "The Domain of Physiology, or Nature in Thought and Language," by T. Sterry Hunt, "London, Edinburgh, and Dublin Philosophical Magazine" (vol. xii, pp. 233–253) for October, 1881; also separately reprinted, pp. 28; S. E. Cassino: Boston, 1882.

ever, been included what we call geology, which is not a separate science, but the application alike of mathematic and of all the natural sciences to the elucidation of both the physiography and the physiology of our planet. So far as geology concerns itself with the history of past life on the earth, or what is called paleontology, it is biological, but in all its other aspects the relations of geology are with Section III. The logical result of this complex character of geology should be either the separation of paleontology from the other branches of geological study, which find their appropriate place in our Section III; or else the union of the two sections through this their common bond.

It will be noticed that in this brief survey of the field of natural knowledge I have not spoken of the technical applications of science, nor alluded to its important aspects in relation to the material wants of life. On this theme, did time permit, I might speak at length. There are two classes of motives which urge men to the pursuit of knowledge; on the one hand, those of worldly fame or profit, and, on the other, the far nobler sentiment which has the finding-out of truth for its object. It would seem as if, by a spiritual law, the great principles which are most fruitful in material results are not revealed to those who interrogate Nature with these lower ends in view. Newton, Darwin, Faraday, Henry, and such as they, were not inspired by a desire for the praise of men, or for pecuniary reward, but pursued their life-long labors with higher motives; the love of truth for its own sake, the reverent desire to comprehend the hidden laws and operations of the universe. To such, and to such alone, does Nature reveal herself. In the material as in the moral order, the promise of achievement is given to those who strive after knowledge and wisdom irrespective of the hope of temporal reward; and the history of science shows that it is such seekers as these who have attained to the discovery of those secrets which have been of the greatest benefit to humanity. The admonition is to all, that we are to seek first for truth and for justice; and with this comes the promise that to those who thus seek all other things shall be superadded.

It is good and praiseworthy to labor to extract the metal from the ore, and the healing essence from the plant, to subdue the powers of electricity and of steam to the service of man. To those who attain these ends the world gives its substantial rewards; but far higher honors are instinctively rendered to those who by their disinterested researches, undertaken without hope of recompense, have revealed to us the great laws which serve to guide the searchers in these fields of technical science; to those who have labored serenely, with the consciousness that whatever of truth is made known by their studies will be a lasting gain to humanity. "Thus," to repeat words used on another occasion,* "it ever happens, in accordance with the Divine

* "The Relations of Chemistry to Pharmacy and Therapeutics," an Address before the Massachusetts College of Pharmacy, by T. Sterry Hunt. Boston, 1875.

order, that the worker must lose himself and his lower aims in his work, and in so doing find his highest reward; for the profit of his labor shall be, in the language of one of old, to the glory of the Creator and to the relief of man's estate."

BRAIN-WEIGHT AND BRAIN-POWER.*

By J. P. H. BOILEAU, B. A., M. D.

ALTHOUGH the connection between the relative weight of man's brain and his intellectual development is very well known, and several illustrations of this connection have been published, I feel assured that the following notes of a remarkable case may not only well be added to the list of those already recorded, but that it is desirable that this should be done. It is the case of an officer who died at Netley last year, and I am indebted to a published memoir for some particulars of his life.

A Scotchman by birth and parentage, he received his early education in Edinburgh, and afterward went to Wimbledon School previous to entering Addiscombe, where his career was exceptionally brilliant. At the final examination there, he scored an unusual total of marks, gained the sword of honor and Pollock medal, and several prizes for specific subjects. On leaving Addiscombe in 1858 he proceeded to India, where he was employed altogether in civil duties. At the time of his death he was superintendent of the telegraph department. With no military distinctions, he was, nevertheless, one of the foremost men in his corps. Highly gifted intellectually, duty no less than inclination prompted him to cultivate his mind as a preparation for advancement, for he held strongly that no one is fit for highly responsible positions who fails to keep himself as far as possible on a level with current events, and with the thoughts, investigations, and discoveries of the day. His wide reading and tenacious memory made him a man of mark in any society. His opinions were his own, formed independently, expressed, if necessary, forcibly, and followed always courageously. He was an exceptional man, and his large-hearted and wide-reaching sympathy won him admiration and love among high and low. His remarkable qualities were as conspicuous in his earlier as in his later years. He was a standard of conduct to his schoolfellows, and, when at Addiscombe, the governor did him the extraordinary honor of making a private report to the Board of Directors of the East India Company, which was quoted by the chairman on the examination day. The reputation with which he started increased daily, and was sustained to the last. But the strain was too great. Exposure to a pernicious climate—and his physical strength led him to expose himself only too carelessly—for twenty-four years, with but eighteen months' leave, weakened a naturally magnificent constitution, and he was compelled to take furlough. His intellectual vigor, however, was shown nearly to the last, and only a few days before death he expressed his capability of undertaking difficult mental work. But a sudden change set in, and in a few days proved fatal.

During his stay at Netley he suffered from extreme debility, induced probably by intractable diarrhœa. A day or two before death he complained of severe headache, and his axillary temperature rose from 101°–102° to 106° Fahr.

It is very much to be regretted that, at the time I was called upon to make the autopsy, I was not in possession of the facts narrated, for, had I been, the examination would have been more complete in many points. The diagnosis of the case was very obscure; but hepatic abscess was suspected, and it was to clear up this point that the examination was made. The severe headache, however, and the rise of temperature, pointed to some cerebral or meningeal mischief, and it was thought advisable to find out if such existed. For this purpose the cranium was opened.

Abstract of Autopsy (made not only with the full permission of relatives, but, I believe, by request).—Cranial bones very dense; dura mater extremely vascular; brain-substance generally firm and normal. On opening the left ventricle pus was observed in the anterior cornu; the origin of this was in the anterior part of the intraventricular portion of the left corpus striatum, which here was quite destroyed and broken down into soft shreds. Before dissection the brain weighed 26,130 grains avoirdupois, or 59·72 ounces. After examination, a portion of it, weighing 22,785 grains, was found to displace eighty-six cubic inches of water; the specific gravity was, therefore, 1·049. The lungs were perfectly healthy, with the exception of the lower lobe of the right. In this there was a circumscribed abscess-cavity, measuring in its longest diameter three inches. It communicated with a small abscess in the liver, through an opening, about the size of a florin, in the diaphragm. The heart was quite normal. The lining membrane of the great blood-vessels was deeply blood-stained, that of the aorta being very much roughened, in patches, by atheromatous degeneration. Jejunum, ileum, and colon normal; no trace of ulceration, but the solitary glands of the latter were large and prominent. The liver presented a uniformly brown color throughout, and was much softened. In the upper portion of the right lobe there was a small abscess, about one inch in diameter, and nearly surrounded by a dense, thick, fibrous envelope. This abscess communicated with the lung. The spleen was slightly enlarged, weighing 4,375 grains. The kidneys appeared to be quite normal; they were enveloped in a large amount of fat.

The chief interest in this case lies in the great weight of the brain, and its high specific gravity, in relation to the highly gifted intellectual power exhibited by the individual during life. As this brain weighed very nearly 60 ounces, it exceeds that of all others usually quoted, with the exception only of Cuvier's, which weighed 64½ ounces, and that of Dr. Abercrombie, which weighed 63 ounces.* Sir J. Y. Simpson's brain weighed 54 ounces, and that of Agassiz 53·4 ounces. It is well known that the average weight of the adult male brain is under 50 ounces. The specific gravity of the brain I examined was 1·049, and this is as high as any recorded. From Professor Aitken's work I find that the average specific gravity of the brain is 1·036, and the highest specific gravity of the densest part of a brain ever taken by Professor Aitken, or any one else, I believe, is 1·049.

The weight of the brain in this case was, in the first instance, taken by the orderly corporal in charge of our microscope room, and recorded by him on the blackboard in the mortuary. I immediately verified its accuracy by weighing the organ myself, and I also verified the correctness of the weighing-machine. The specific gravity was taken very carefully. Surgeon-Major Hogg, Army Medical Department, was present at the time.

The average cranial capacity of the adult male head is, I believe. about 90 cubic inches. Cuvier's is reported to have been about 118, In the case which I now record it must have been about 108.—*Lancet.*

THE CELL-STATE.

By Professor FERDINAND COHN, of Breslau.

NOTHING is more sure than that all life is subject to age and death, and yet nothing is more contradictory to our feelings. In the vigor of youth our body feels as if it was created to last for ever; why must the highest work of art wear out and break down with time? The more formidable the contradiction between inexhaustible life-joy and inevitable fate, the greater the longing which reveals itself in the kingdom of poetry and in the self-created world of dreams hopes to banish the dark power of reality. The gods enjoy eternal youth, and the search for the means of securing it was one of the occupations of the heroes of mythology and the sages, as it was of real adventurers in the middle ages and more recent times. . . . But the fountain of youth has not been found, and can not be found if it is sought in any particular spot on the earth. Yet it is no fable, no dream-picture; it requires no adept to find it: it streams forth inexhaustible in all living nature.

* A case is recorded in the "British Medical Journal," October 26, 1872, by Dr. Morris, in which a brain examined at University College, London, weighed 67 ounces. It was that of a bricklayer, who could neither read nor write.

Nature continues eternally young; the earth adorns itself every spring with leaf and flower, having the same freshness and youthful vigor as when for the first time He "let it bring forth grass, the herb yielding seed, and the fruit-tree yielding fruit after his kind." The grasses and flowers, it is true, which this year are cut or withered, the leaves and blossoms which the wind has to-day blown from the trees, will not assist in forming its robe in the next spring, but Nature draws out new shoots from the old roots, new leaves from the old branches, and thus rejuvenates herself with every new year. And although the human race, although also the other kinds of animals and plants, show as yet no trace of age in spite of the numerous thousands of years in which they have dwelt on the earth, still each individual is perishable, it grows old and dies; but new generations shove themselves uninterruptedly into the gap, so that the whole abide in the freshness of youthful vigor. Rejuvenation so dwells in nature that every individual runs through a limited circle of development, and is finally worn out and cut off, to be replaced by fresh members which pass anew through the accomplished cycle.

I.

If we apply this view which we have gained of the rejuvenation of nature to the consideration of a single being, whether it be man, animal, or plant, we shall perceive that all life rests upon a constant renewal. Life is an uninterrupted contest with death, which attacks it every moment, but is beaten back by rejuvenation. It would be an error to represent a living being as anything constant, its appearance as anything steady; life in truth resembles a water-fall, which only apparently preserves a constant form, while in reality none of the particles of water keep their places, but are continually removed and replaced by new ones. The visible form of stillness is kept up only in perpetual movement. Life resembles a flame, which restlessly consumes itself and can shed an even light only when new particles come up in place of those which have been burned, only to be dissipated in their turn a moment later. So in living bodies the combination and arrangement of the matter on which their outer form and internal disposition depend are at no two instants the same, but an uninterrupted change of matter is taking place. The particles which are together in this moment at one point are in the following moment separated and replaced by others. For only a short time are the atoms of which bodies are built up adapted to the service of life; sooner or later they leave it in order to follow the free play of the forces of attraction which join the elements in the enduring combinations of lifeless nature. Therefore, the living body is obliged constantly to take up from without new elements of nourishment, by means of which it repairs its loss; and these insinuate themselves so closely in the place of the separated ones, that even the eye of the naturalist, armed with the most effective aids supplied by modern science, has only recently remarked, after a long time, that any change has taken place.

In reality every living body is subject to an uninterrupted change, which goes on in an appointed course. Life is like a stream, which gushes out of a hidden spring; slowly increases, flows on for a time with even strength, finally with diminishing velocity, to disappear in the sea of eternity. We designate the course of changes which every living being, plant, and animal, as well as man, goes through, as its development. Development begins with the moment of birth and ends with death.

But with the death of the single being its race does not disappear; the property dwells in every living being by which a part of it can drop off from the whole, continue to develop itself independently, be nourished and rejuvenated by a change of matter. We call this dropping off of a part, capable of development, from the whole, propagation; with propagation is transferred the history of development; the separated part, which we denote as an egg or spore, a seed or embryo, a bud or spawn-knob, passes in substance through the same course of changes as the whole from which it has been separated. Like arises from like; the children resemble their parents, and, as these again resemble their ancestors, the character of the species is kept up essentially unchanged, in spite of the perishability of individuals, through all the generations.

That life is nothing but a constant development and an uninterrupted rejuvenation is expressed in the plainest and clearest manner in the world of plants. It is, indeed, not easy to comprehend the life of plants aright, and many regard the term as a figure of speech, not properly applied. Plants, they say, do not feel or move; they have no consciousness, no soul, like animals; how can we speak of their life? If motion, feeling, and consciousness alone constituted life, there might be some doubt as to whether plants lived, though it would still be worth while to inquire whether these higher attributes were really wanting in plants. Darwin has lately shown, in connection with many older observations, that all the parts of plants participate in a regular circling motion, and that single organs show sensibility enough to make them comparable with the brains of the lower animals. But when, instead of the highest acts of life, we confine ourselves to its general and essential manifestations, it becomes undoubtedly clear that plants are living in the same sense as animals and men. Only plants are distinguished, not from animals generally, but from the higher animals that rank nearest to men, and from which our conceptions of animal life in general have been formed, in that in them unity, or individuality, is expressed in a much more imperfect manner. The mammal, bird, fish, insect, is a separate, single, and indivisible being. Its members are fixed and limited in number; not one of them can perform its functions when separated from the whole. No part, not the smallest, can be separated from the body without the whole suffering.

It is very different with the plant. A tree indeed appears to be a single being, sinking the net-work of its roots into the ground, raising its slender trunk into the air and spreading out above the web of its limbs and boughs. The members of which the tree consists may be regarded as its organs. It sucks up its nourishment through its roots, it breathes through its leaves, it propagates its species through its flowers. But the connection of these members with each other is of an infinitely looser character than that of the organs of the animal. I can strip as many leaves as I please from a willow, the rest lives on; I can cut off its limbs, those that are left grow more vigorously; I can cut it down near the roots, new shoots spring up from the stump; I set the rootless stem in moist earth, and it continues to live. If I wish to make a layer, I have only to plant the end of a bough, and it takes root and grows. In many plants a single leaf has the capacity of living and growing. The plant is not therefore indivisible, like the animal; its individual members are in a much higher measure independent and competent to live. We may say the animal is a single being, each of its members is only a part, not itself a whole, only an organ, not itself an individual. The plant, on the other hand, is a composite being, a chain of individuals, each of which possesses an independent life, but all of which are connected in a collective life of a higher order; the plant is an organism the organs of which are themselves organisms.

This relation may be made clear by a suitable figure. A state is, without doubt, in many respects a single organism, which maintains an independent, often sharply defined, unchanged character through centuries, and marks its domain as an indivisible, also as a real individual. Each state has its own development-history: it is founded, it grows, reaches its prime, and decays; it has its life-economy, for the functions of which it maintains its particular organs, its officers. The state also acts in external affairs as a single organism; it makes war, it establishes enterprises for the general benefit, it builds important works, etc. But if the state thus appears as a single whole, so also it may be regarded on the other side as a collection of provinces; each province is a state in miniature, likewise organized in itself; and history furnishes us with numerous examples in which single provinces have been able to cut loose from the collective state and maintain themselves as independent state-organisms. The province, again, can be regarded as an association of villages which represent the smallest social organizations; every village is also a state in miniature, with independent economy, and capable of maintaining itself independently in case of necessity, and, in fact, of growing up, as Rome, Carthage, and Venice have shown, into mighty states. If we carry our similitude to the end, we may liken the animal to a compact, centralized, unitary state, the members of which have entirely lost their independence, and in which a single will rules the whole; while we may represent the plant as a freely organized federal state, the members of which, in spite of their resignation to the whole body, have yet preserved a certain degree of independence and self-administration.

In the federal state of the plant the limbs and boughs correspond to the provinces, the leaves to the villages; but the village is not the last member of the chain: it is itself a union of citizens, each one of whom, though a member of the state and the village, is an independent being who lives first for himself, and has his own household, all of whose efforts are first directed to the maintenance of his own existence. But while with a just egoism the citizen knows his own good as his immediate object, he thereby participates directly in the advancement of the state organism and contributes to the support of the whole state. Every citizen goes through his independent development from birth to death; but the village does not die with the death of the individual, for in his stead come his children to fill the vacant place; and the village and state are renewed in the unbroken succession of generations.

It is the same in the plant-state. If we compare the leaf with the village, it also consists of a larger or smaller number of individuals which may be regarded as independent organisms. The citizens, through the union of whom the plant-state is formed, are called by the botanist plant-cells. All plants, without exception, are composed in all their parts of cells, just as every building, from the palace to the hut, consists of building-stones or timbers. Every plant-cell pursues an individual life. Its first effort is only to maintain and develop itself; it takes its own nourishment and assimilates it, and finally dies, after having, as a rule, first left a posterity in its place. As the cells unite to form cell-villages in the leaves, these unite again to form the provinces of the foliage-boughs, and enter into an interchange of life with each other, and so they maintain the life of the whole plant in the same manner as the collective state-life comes into being through the interworking of the lives of the individual citizens. What we see going on in the life of the plant in the germ and shoot, in flower and fruit-bearing, are only head and state actions in the development of the cell-state and its citizens.

Our eyes can not perceive these citizens of the cell-state. It is not strange, then, that their existence escaped the knowledge of naturalists till about two hundred years ago. They would still be concealed, and the key to the comprehension of plant-life would be withheld from us, had it not been for the microscope.

We owe it to the microscope that, where the naked eye perceives only uniform masses, we can now distinguish a wonderful diversity of beautiful tissues; and that where a rigid stillness seemed to prevail, a fullness of life-processes quite incomprehensible to us is concealed.

The microscope shows us in the plant, which was able to give to the naked eye only obscure signs of its inner life, a highly organized state-life of restless development and renewal.

We have represented the citizen of this state, the plant-cell, as an exceedingly simply formed being: it consists of a round body of soft, slimy substance, like a sack, the interior of which is filled with a watery juice. The soft substance, forming the wall of the body, is called protoplasm; it is the most important matter in all nature, for it alone is the bearer of life. With slight changes it forms not only the bodies of all plant-cells, but also the white and yolk of the egg, flesh and blood, the substance of the brain and nerves, milk and cheese, the skin and hair of animals. While in lifeless nature nearly every kind of stone has a different chemical constitution, in the world of life one and the same fundamental substance forms the basis of the bodies of plants, animals, and men.

But if the plant-cell consisted simply of soft protoplasm, it would not be able to resist the presence and assault of strange bodies; therefore it is surrounded with a hard shell, which it prepares as a dwelling and for its protection, in a similar manner as the snail forms its shell, by secreting over its surface a matter which soon hardens into a firm, transparent envelope. This shell, which is called the cell-wall, does not show the most minute opening, but incloses the protoplasm perfectly tight. We might, therefore, liken the cell to an egg in which the soft, living contents are concealed in the hard shell.

Plant-cells vary greatly in size. Those of elder-pith and of the begonia-leaf may be perceived, with the naked eye, as resembling an extremely delicate lattice-work; the pollen of rye and of melons separates in water into little dust-particles—single cells, just at the limit of visibility. A drop of malt-yeast, on the other hand, is resolved under the microscope into millions of oval fungus-cells, one or two thousand of which would hardly fill the space of a centimetre. Plant-cells average about the size of a hair's-breadth, many only about a third or a fourth as much; others are larger, and particularly longer; the single fibers from which cotton and linen threads are spun are plant-cells which, although very slender, are from two to six centimetres long.

But in nature nothing is great and nothing little, and there is room, even in the smallest cell, for the greatest diversity and development of the powers of life. A continuous formation and transformation, origin and decay, a constant change of matter, is going on in every cell; reception and assimilation of food, inspiration and expiration; certain atoms which have become of no use for purposes of life are cast aside, others are taken up from without in their places; on this food and change of substance depend the renovation of the cell and the maintenance of its life. Evidently not solid substances are appropriated, for we know that the cell is incased in a perfectly closed envelope; but liquid and gaseous foods can be easily absorbed. Although the most perfect microscopes have never made any holes visible in the cell-envelope, there is not the slightest doubt that this envelope is porous, like a fungus, but that the pores are infinitely finer. Therefore, we may understand that, when a cell is placed in a fluid, the envelop absorbs it to fullness, and conveys to the inner protoplasmic body as much as it requires; and, inversely, certain parts of the cell-juices, which the living protoplasmic body does not need for itself, are transpired through the pores of the envelope and become applicable to the use of other cells; and the same may take place with air and gases.

The old naturalists believed that all bodies were composed of four elements—fire, water, air, and earth. Modern physics and chemistry have divested these elements of their high importance; but they are still full of meaning to the life of plants. Earth, air, and water are the food of plants; fire, or rather light and heat, are the forces that set agoing the play of life in the cells. The most important food of plants is contained in the mineral solutions which the water, penetrating the soil, extracts from it, and in the oxygen and carbonic acid which they derive from the air.

Water, earth salts, and the gases—the raw materials which the plants suck up—are changed within the cells into starch and sugar, gum and woody fiber, albumen and wax, oil and resin, into powerful medicines and deadly poisons. The simplest plant possesses an art which the most skillful chemist has not been able to learn from it. It is true that the chemist can artificially prepare in his laboratory many of the substances which the plant-cell likewise produces; he can convert the starch of the potato into the sugar that gives the wine-grape its sweetness; this, again, he can transform into the fruit-acids which, in connection with the sugar, give the berries their fresh and agreeable taste; he can even produce the flavor of the fruits from the fusel-oil which he obtains by the fermentation of the sugar. He can make the oil of bitter almonds from benzoic and formic acids; he can, with as good art, imitate the pungent taste of the pepper, and the biting one of the mustard-seed, and the narcotic poison which only the nightshade has hitherto prepared for the healing of sore eyes. He can produce from the sap of firs the crystal-needles of the vanilla, for which a Mexican orchid has heretofore been obliged to give up its pods; from the distillation of wood he obtains a smoky fluid, from which he procures salicylic acid, for the production of which the flowers of the meadow-sweet or the bark-tissues of the willow were formerly required; and from this he makes also the ink-coloring gallic acid, which formerly only a little wasp knew how to draw out by its sting from the cells of the oak, and the aroma of the wood-ruff. He has made the work of the cells in the madder-root superfluous, for he has fabricated its costly dyes, along with a hundred other splendid pigments, out of tar-oil and stone-coal; and is now on the point of taking its work away from the indigo-plant by artificially producing indigo. But a raw material which has at some time been brought forth out of the laboratory of a living plant-cell always lies at the foundation of all these manipulations of the chemist, wonderful as they are. And, notwithstanding the immense progress that modern chemistry has made within the last ten years, its art is still limited at this point: no prospect yet exists that it will be able, artificially, to produce the most important of all the substances that go to build up the bodies of animals and plants, and to form their living cell-tissues—protoplasm, or the envelope of the plant-cells, the matter of the muscles and nerves. Chemistry shares this limitation of its means with animals. No animal can live on air, water, and earth alone, like the plants; no animal can combine the simple chemical combinations, as they occur in lifeless nature, into the life-substance protoplasm. The animal must draw the substance of his flesh and blood from the plant, for his own vital forces are not competent to produce it. The plant-cells alone possess the faculty of ennobling the simple combinations of lifeless nature into matter fitted for life. Every cell, furthermore, possesses another art, that of forming different fabrics out of the same raw material. Hence arises that infinite diversity of substances of different properties which are drawn from the vegetable kingdom. Close together, in the shadow of the same wood, grow crow-foot and wood-ruff, centaury and nightshade; the same soil gives food to their roots, the same air plays around their foliage; and yet the cells of one secrete a pungent, those of another a narcotic poison, those of a third a bitter medicinal juice, those of a fourth an aromatic flavor. The cell utilizes a part of its food for its own growth; but, sooner or later, the growth ceases, and the cell, keeping the form and size it has acquired, becomes a permanent cell. It is round or oval, or resembles a many-sided crystal. Some cells become flat and square, like a tile; some put out rays, like a star, or form a zigzag, like the wall of a fortress; many lengthen themselves out. The inner structure, also, of the cell changes with age; the envelope, delicate and thin in youth, afterward receives accretions and ornaments. Some cells have within a hollow screw-way, like a winding stair; in others, the inside is covered with beautiful nettings, rings, flutings, or lattices. Most cells thicken their casings, as the oyster does, by adding new layers over the older ones; and, when their hollows are quite filled up, they may rival stones and bones in hardness, as, for example, the cells of the iron-wood and the ivory-nut.

As the cell-wall grows thicker, fluids and gases penetrate its invisible pores with more difficulty; and with continuous increase of thickness the living protoplasmic bodies inhabiting its interior must finally die for want of food. They in effect build their own coffin, immure themselves living in their own cell-prison. But a wonderful provision prevents the food being entirely cut off. While the cell-wall is arch-ing itself up more closely and thickly, a few doors and windows are still left open in it, through which communication may still take place with the adjoining cells; this occurs by the cell-wall not becoming strengthened at particular points; and when, in the course of time, the shell has become still thicker, these places appear as pores or canals, which lead outwardly from the interior of the cell. And it is worthy of remark that at each point where such a canal penetrates the thickened cell-wall a corresponding passage is also left open in the next cell, so that the two canals meet each other, and are only separated by a thin partition. Communication continues uninterrupted by these pore-canals.

The plant-cell is, nevertheless, subject to the fate of all life—it grows old and dies at last. It seldom survives a summer; toward the end of the fall its activity becomes weaker. Dissolution gradually overcomes the dead protoplasmic bodies, and only the empty cell-wall is left, which may continue to exist as a vacant chamber for years and centuries after the living nucleus has perished. As a rule, the cell propagates itself before it dies; as an earth-worm may be divided into two parts, each of which will become an independent individual, so the parent-cell divides itself into two daughter-cells, which supply the place of the mother, and continue their life-activity with renewed vigor.

II.

Such in its principal features is the economy of the plant-cell. It is fed by the absorption of fluid and gaseous foods; it elaborates those foods into the most diversified products; it respires; it strengthens and thickens its shell, yet in such a manner that it can continue in living intercourse with its neighbors; it propagates itself by splitting into daughter-cells; it grows old and dies. Let us now glance at the arrangements and laws according to which the cells act in organic connection as citizens of a single state. As there are wild bees that do not live together in a hive, as there are human tribes that wander around in the woods without organic connection, so there are plant-cells that remain isolated during all their lives; they all perform in the same manner the business of their whole existence, which is highly primitive, and unadapted to perfection; their progeny does not continue in social connection, but separates into wholly free individuals. Such plants, which always consist of single cells, are called one-celled; they are found among the lowest forms of the microscopic world, among the algæ and the fungoids. The green coating that covers the rocks, the tree-trunks, and the shingles of the roof, is resolved by the microscope into innumerable green round cells; the brown scum that floats upon ponds and ditches exposed to the sun, the yeast-plant, the bacteria that produce putrefaction, are one-celled plants of this kind.

Generally, however, the plant-cell is, like man, a social being, which finds its true calling only in state-life. In most growths, from that of the moss to that of the oak-tree, an incredible number of cells come together to form an ordered state ; the number of cells in a small plant may be compared with the number of the inhabitants in the most powerful kingdoms ; and I have estimated that at least ten million cells live together in a potato five centimetres (about two inches) in diameter, and that a pine-stem twenty-five metres (about eighty feet) high and twenty-five centimetres (about one foot) in diameter, of symmetrical growth, contains more than a hundred milliard wood-cells.

The leading idea that knits the plant-cells into a state-organism is the same as in the bee-hive or the human state, the division of labor. Each cell possesses its individual life and passes through its particular course of development ; it, however, does not undertake all the works of life, but limits the circle of its activities so as to reach a greater perfection within a smaller limit. In this it works not for itself alone but for the other cells also, while it commits to them those requirements for the satisfaction of which its individual activity is not sufficient. Thus the different functions are so divided among the different cells that one makes this, another that, occupation its own special business. The cells of the cell-state so arrange themselves in their different offices that they work mutually into each other's hands : one lives for all, all for one. The more perfectly the division is carried out, the more completely can each cell fulfill the duty for which it is designed ; the more highly organized is the cell-state, and the higher position does the whole plant take in the order of growths.

As in the bee-hive there are working-bees, so in the cell-state of the plant there are working-cells ; other cells are fitted for sexual existence, like the drones and the queen in the bee-hive, so as to insure the production of posterity and the foundation of a new stock.

The cells which discharge the several functions in the plant are not scattered confusedly in the mass, but are always grouped in greater or smaller numbers of individuals precisely adapted for this or that function, and together form a tissue. Plant-anatomists distinguish three kinds of tissues, each of which discharges a particular function : The fundamental tissue is composed of the cells which are the real workers in the state ; the circulating tissue, of those cells on which the duty of transportation is laid ; the bark-tissues, of those to which is assigned the protection of the cell-state against the outer world. We might designate as a fourth class the reproductive tissues, as including the cells adapted to propagation, which are producing by continuous divisions new colonies, new leaves and flowers, new buds and seeds.

The cell-state is, to speak with Herbert Spencer, organized after the type of an industrial state, in which numerous industrious workmen are co-operating on a footing of democratic equality to ennoble the raw material of lifeless nature and convert it into the precious and diversified productions of life. The fundamental tissue in a measure represents the working-class ; trade is represented in the cells of the vascular tissue, which are engaged, by means of well-trodden routes of communication, in supplying the most remote parts of the domain quickly and abundantly with food and raw material and in exporting the finished fabric. But a defenseless kingdom would be an easy prey to its enemies; therefore the cell-state maintains, but peaceably, and with no view to aggression, in the cells of its bark-tissues, a standing army, on which depends the defense of the whole realm at its borders. As Sparta believed it was most securely defended by the living walls of its citizens, so does the cell-state. The cells of the bark-tissue form a close cordon, through which no rain-drops, no hurtful gas-puff, no hostile animal, no disease-generating spore can penetrate. They wear a hard, siliceous armor, or are protected by an impermeable coating of wax. They have no other purpose, they do no other work, than in compact array to ward off hostile attacks. Single cells advance before the line and oppose attacks with sharp-cutting weapons, finely pointed briers or thorns, or weave themselves into intricate abatis, in which hostile insects become entangled by their feet. The points of many of these thorns are poisonous, as in the nettle, which, when touched by the hand, breaks off and remains in the skin, and fills the invisible wound with one of the strongest poisons known to nature and science.

The cells of the bark-tissues are locked so closely to each other that, like the members of a brave phalanx, they would be torn apart before they would separate from each other; and they can be separated from the other tissues only as a connected layer, a thin membrane that may be drawn off from all plants, and is known as the epidermis. This living cell-fortification is interrupted in many places by round openings like gates, which may be closed by a couple of cells as if with double doors, by the opening of which the access and egress of gases and vapors to and from the interior are permitted.

Thus the plant is protected from external enemies; but its most dangerous adversaries are the hungry members of its own kingdom. Not all plants are supported by peaceful labors; there is among them also a predatory horde, whose members, the parasitical plants, unfit for honorable occupation, and bearing the marks of their baseness in their pale color and offensive smell, lurk in the darkness and in concealment till they can find some victim to attack and overcome. Now is the strength of the living wall of the plant tested: as long as it is unbroken, the assault is repelled; but the persistent enemy presses into the smallest opening. Woe to the tree from which the wind has broken a limb, or in which the careless gardener has made a bad cut! The microbes, whose spores are floating through the air in unwholesome clouds, and fall with the dust, settle upon the wounded surface, and soon its whole cell-structure is pervaded by their destructive webs.

In peaceful times the other citizens of the cell-state attend to their business undisturbed, under the protection of the bark-cells. The cells of the fundamental tissue, which is inhabited by the working-people proper, unite in close association; between them courses, with numerous branches, a system of canals, which are connected with each other like net-work, and find their exit through the clefts. In this manner the air which they require for food and respiration is introduced to the cells, and by the same road escape the gases and vapors which the cells throw off, and which need to be removed.

The fluid foods are carried to the working-cells through the vascular tissue in a special system of ducts, conduits, and fibers, which, joined in strings and bundles, penetrate all the organs, the roots, stock, limbs, and leaves, and are known as the ducts, or vascular bundles; they may be most easily perceived in the leaves when held against the light, where they form the most beautiful vein-work. These conducting vessels are also traffic-roads, in which the products of the working-cells of the main tissue are transported to other places, where they are put to use. Thus an unceasing activity, like that of the bee-hive, prevails in the cell-state of the plant. Gases go in and out; juices circulate up and down, absorption and evaporation, distillation and refining, forming anew, remodeling, or destroying the old, are going on all the time without rest or cessation for an instant. As long as the cells live, they are active; when they cease to work, their death is near. No one thinks, when he looks at a plant, what restless activity is at work within it, for the cells perform their artful labor in stillness, without buzzing and flying around as the bees do.

The wealth of those lands that possess coal-mines and ore-beds is highly prized. But these treasures are not confined to single provinces. Immense mines of ore, inexhaustible coal-beds, surround us wherever we may be. For the minerals that are contained in the field-soils are quite as precious as are the mines of iron and zinc, yes, even of gold and silver. Man can not live on gold and silver; but out of the minerals of the field-soil, out of potash, lime, phosphoric acid, ammonia, and sulphuric acid, the cell-state of the plant prepares bread on which we live, linen in which we clothe ourselves, wood out of which we make our vessels and tools, and the remedies which when we are sick restore our lost health to us. The cells of the roots, like hewers and miners, sink numerous shafts in the spaces assigned to them, drive their galleries toward all points of the compass, in order to break up these mineral treasures, separate them from the incasing stone, and set the machinery of service in motion; day and night with inexhaustible diligence, they extract atom by atom of potash and ammonia, phosphoric and nitric acid, and, without working up their ore, deliver it over to the conducting vessels which transmit it by their powerful system of sucking and forcing pumps to the stem and the leaves. The leaves are cell-villages which perform their daily tasks in the air and the light. Their principal business is to obtain coal, which is the chief constituent of the vegetable body. Our atmosphere is an enormous coal-mine, many miles in thickness, that can not be exhausted in thousands of thousands of years. The coal, indeed, is not found pure in the air, any more than the metal in the ore, but is in combination with oxygen as a transparent gas, carbonic acid, and a peculiar art is required to separate it.

In the mining districts, smelting-houses are erected beside the pits, where the noble metal is extracted from the impure ores. The green cells of the leaves combine the art of the miner with that of the smelter, and have the power of extracting the pure carbon from the atmosphere. In order to perform this work, they must be shone upon by the sun, for the sunlight alone can excite in them the marvelous faculty. Having extracted the carbon, they combine it with water and with the mineral substances that have been drawn from the soil, and prepare from them the living matters out of which the plant itself builds up its cells, and which, taken up into the body of an animal, is transformed by it into flesh and blood.

As bees do not at once consume all the honey they collect, but lay away a large portion of it in special cells for winter provision, so a portion of the cells in the plant are set apart for the storage of capital in anticipation of the necessities of the future. On the approach of winter the leaves discharge the greater part of what they have produced through the conducting vessels, which convey it to a subterranean magazine. The cells of the root-stock, the tubers, and the bulbs, protected from the frost by their covering of earth, are filled with starch, albumen, and other valuable food-material, which will be used again in the coming spring when they will be most needed, for the expansion of the leaves and flower-buds. When we eat a potato, we appropriate to our own nourishment the provision which the careful mother-plant has laid up in its cells during the previous year for the growth of the next spring; and we do what is substantially the same as when in the fall we rob bees of a part of the honey which they have gathered for the supply of their own state.

A necessary consequence of the short duration of the life of the single cell is that a part of the plant, the cell-village, in which the life-processes are now active, is generally dead in the next year, and unfit for all work. Therefore the cell-state is subject to a constant mortality. The leaves which perform their work in the summer wither and drop off in the fall; the cells of the root, also, which then drew up the fluids from the soil, and those of the stem, which conducted it upward, have at the same time grown old—have become woody, as the botanist expresses it.

The greater part of the plant does not, in fact, survive the first year. Most herbs sprout in the spring, blossom in the summer, ripen their seed in the fall, and perish in the winter. Trees, on the other hand, bushes and shrubs, possess a regular economical administration.

They lay up, till fall, provision in their stems or roots, which does not come into use again until the next spring. And, when the collected capital enters into circulation again after the first warm days, the old cells are not able to undertake anew the business of turning it to use. The plant does not put its new wine into old bottles. It forms new cells, new organs, adapted to the demand of the new season. Now those tissues which we may call the procreative tissues come into play. Their cells begin to undergo a continuous division; their number is multiplied—new colonies, new cell-villages are founded. New points are formed at the ends of the roots, the young cells of which suck food from the soil with refreshed vigor; a new conducting tissue is formed in the stem between the wood and the bark, representing a new yearly ring. A grand act of renovation has also been in preparation at the ends of the limbs and twigs and at the bases of the leaves. Little cones of reproductive tissue are developed at these spots, in which innumerable cells originate by division, and, in accordance with an innate structural plan, a definite number of vesicles shoot in most symmetrical order of arrangement from each of these cones. Every cone is the beginning of a little stalk, the vesicles that grow from them are the beginnings of leaves; the whole structure is covered with thick scales and is now called a bud, in which the tender beginnings of leaves are protected by the scales from frost and storm. The buds are started in the summer, completed in the fall; are dormant during the winter, and are awakened to new life in the spring. The scale-armor now becomes superfluous, is cast aside; the little leaves rack and stretch themselves, and joyfully spread themselves out in the air and light; the little stalk grows longer and longer; in a little while the buds have shot out into young limbs, in the fresh foliage of which, excited by the light of the sun, the restless labor of the cells begins anew; or, after a marvelous transformation into flower-stalks, they produce those sexually developed procreative cells which are destined by a series of mysterious processes to found a new cell-state.

Thus is the cell-state of the plant subject to a continual rejuvenation. The individual citizens (the cells) and the villages (the leaves) have but a short life, but the state in its entirety may endure for centuries in lasting youth. If the hands of men, or the elements, do not inflict a violent death, the cell-state, as so many primitive giant trees have shown, may outlast the mightiest kingdoms of men.

Gifted writers on social politics have recently endeavored to illustrate the development and interrelations of human society by analogy with a living being and its cells. We have taken the converse course, and have endeavored to make the life of the plant and its cells comprehensible by a similitude with a state organization and its citizens. We have endeavored to show that what man has regarded as the highest ideal of his conscious effort in the struggles of the world's history has been prefigured in quiet accomplishment in the world of plants.

It is the representative of the idea of the state which leaves its individual citizens to develop themselves freely according to their inborn natures, and to work together on an equal footing for the good of the whole; which preserves to the villages and the provinces their self-administration, and yet subjects them in every instant to the higher interests and laws of the whole; which appears ready armed against the external enemy, preserves unity and peace within; which applies the capital accumulated by the common labor of all the citizens to the advantage and advancement of the whole, without letting it be preyed upon by any; which in untiring activity never suffers a pause, and by continuous renovation endures for centuries, always increasing, always blossoming, and always bearing fruit.

AMERICAN AND FOREIGN ASPHALTS.

By E. J. HALLOCK.

BITUMINOUS substances, apparently of organic origin, are found in various parts of the world. Sometimes they occur in a free state, as in the Island of Trinidad, and at others impregnating calcareous rocks, or serving as a cement to hold the particles together, as at Val de Travers or Seyssel.

For several reasons the asphalt lake in Trinidad possesses special interest for us. The island, which is the southernmost of the Lesser Antilles, lies off the northern coast of South America, and is easily accessible from any of our sea-ports. Here, amid the most luxuriant vegetation, is a lake three miles in circumference, on the surface of which lies a crust of asphaltum of such tenacity that in the rainy season a person can walk across it; but, under the influence of the hot sun, it softens to a thick tar. This crust receives accessions from beneath, and formerly it would overflow and run into the sea, more than two miles away. A similar substance, known as "Jew's pitch," is washed ashore in considerable quantities around the borders of the Dead Sea. In Texas, south of Shreveport, there is said to be a pitch-lake containing large quantities of bitumen, but little is yet known about it. In Southern California there are accumulations of asphalt on the coast at Santa Barbara, San Luis Obispo, etc., which resembles, when pure, that from Trinidad. It promises to supply the wants of the western coast, as Trinidad will that of the eastern part of this country.

In Kentucky there is a considerable quantity of asphaltic mineral which may some time be utilized for road-making.

An interesting and valuable asphaltic mineral, known as Albertite, is found in New Brunswick; and a similar one, called Grahamite, occurs in West Virginia and other parts of the country. In the mountains west of Denver, in Colorado, is a vertical bed of hard and brittle asphalt, not unlike Grahamite, while Albertite is found in small quantities in Lorain County, Ohio, and Casey County, Kentucky.

Bitumen is likewise found in Cuba, and is brought into commerce under the name of *chapopote*, or Mexican asphalt.

In Europe asphalt occurs chiefly in limestone, which forms, when crushed and packed, an excellent pavement. The principal points at which it is found are the following: Val de Travers, in the Swiss Canton of Neufchâtel, fourteen miles from Neufchâtel, and sixteen or seventeen miles by rail from the French borders; Seyssel, on the Rhône, in the French department of the Ain, about thirty-three miles from Geneva; Lobsann, a small town in northern Alsace; Vorwohle, in Braunschweig; and Limmer, near the city of Hanover. The Italian province of Caserta, in the neighborhood of Naples, supplies Rome with an asphalt much used for terraces and flat roofs.

The quantity of bitumen in these limestones and the manner of its dissemination are quite varied, but it is generally found that the softer limestones contain more bitumen than those which are harder. The average amount is about ten per cent, but it sometimes reaches twenty or thirty per cent, and occasionally there are cavities in the rock which are filled with bitumen. At other times the quantity sinks to five per cent, or less, while nodules of limestone entirely free from it are also found. The value of the rock depends on the percentage of bitumen, and on other circumstances. If the stone is to be used for making mastic, the higher the percentage the more valuable it is; but, if used directly for paving, a uniform distribution, not exceeding eight or ten per cent, is desirable.

Asphalt-stone, to which Malo limits the name of *asphaltum*, varies in color from gray to brownish-black, according to the richness in bitumen; that of medium quality closely resembles chocolate in color. That which is poor in bitumen is hard, and rings like ordinary limestone; but the fatter rock, when struck with a hammer, gives forth a dull thud, like a block of wet plaster, and takes an impression from the blow. If it contains more than ten per cent, it crumbles in the hand, and can be cut with a knife, like chocolate. Good stone, with about ten per cent of bitumen, has a specific gravity of 2·1. Some asphalt-stone is of a spongy, hygroscopic nature, and consequently lighter.

One peculiarity of the natural rock-asphalt is that, when heated over a fire, it breaks up into a brown powder, and then, at a higher temperature, all the bitumen is expelled, leaving a pure white powder. An unsuccessful attempt was made in the Paris Conservatoire des Arts et Métiers to imitate this asphalt-stone by forcing thick, pasty bitumen into pure limestone by great pressure. When, however, the lime-stone was boiled for a long time in a liquid mass of asphalt, it became so completely saturated with it that the innermost fractures resembled the natural asphalt-stone; but it differed from the latter in this most important property, that it did not crumble to a powder when heated. On the contrary, the absorbed bitumen was expelled by heat, leaving a hard limestone, instead of a calcareous powder. From this it seems probable that the particles of the natural asphalt-stone are simply cemented together by the bitumen, and both must have been deposited at the same time.

In most mines the strata dip slightly toward the horizon. They vary greatly in thickness; sometimes there is only one stratum, at others there are several superimposed on each other or separated by strata of harder limestone or shale. At Val de Travers the strata that are worked are from two to six metres thick, and rest on hard, non-bituminous limestone.

In some places it is mined in open trenches, in others by means of shafts and subterranean tunnels. At Val de Travers, Seyssel, and Lobsann, the latter alone are employed. The rock is blasted out with powder, which works better in soft rock than dynamite. The holes are bored with an ordinary hand-auger. At Limmer, owing to the water in the mines, it is necessary to use dynamite.

The percentage of bitumen in the different varieties of asphalt-stone is as follows: That from Limmer, 14·3; Val de Travers, 10·15; Lobsann, 12·32; Ragusa, 8·92; Seyssel, 8·15; Vorwohle, 8·50. It is estimated by extracting it from the finely pulverized mineral with carbon disulphide, benzene, or other solvent, and weighing the residue after the solvent has evaporated. The quality of the bitumen is determined by heating it to 430° or 440° Fahr.; the less it loses by evaporation the better its quality. The powdered mineral from which the bitumen has been extracted should be white and soft. If it has a gray color, and feels harsh or sticky, it is of poor quality. Too much dependence can not be placed on chemical analyses, for much depends on the physical properties as well.

The larger portion of the asphalt-stone used in Europe comes from Val de Travers, which produces about 25,000 tons a year; Limmer is not much inferior in its yield, which amounts to about 21,500 tons; Seyssel furnishes 13,000 tons, and Lobsann about 9,000 tons. That which is mined at Limmer and Vorwohle, being very rich, is only used for making mastic.

The first operation to which the asphalt-stone is subjected, when it reaches the factory, is pulverization. For this purpose several different machines are in use, the ordinary stone-breaker being unsuited to the purpose. Four or five of these are figured in Professor Dietrich's new work on "Asphalt Streets,"* to which we are indebted for many of the facts in this article.

The powder thus obtained may be employed directly for the com-

* "Die Asphalt-Strassen,' E. Dietrich, Berlin, 1882, pp. 207.

pressed asphalt pavements, or converted into "mastic" by mixing it with one tenth to one seventh its weight of purified bitumen from Trinidad and cooking five or six hours. It is then poured into cast-iron molds without bottoms, which are placed on the sanded floor of the shop. These blocks of mastic are fifteen inches in diameter and four inches thick, weighing fifty or sixty pounds each. Those made at Val de Travers are hexagonal in form, bearing a trade-mark of a cross and $\frac{V}{T}$; those from Seyssel and Lobsann circular; the others oblong, with rounded corners.

The Val de Travers mastic and asphalt rock are imported by the Neufchâtel Asphalt Company (54 Astor House, New York); the Seyssel mastic by the New York Mastic Works (35 Broadway); the Limmer and Vorwohle rock asphalt by C. Wichtendahl (111 Broadway, room 97). In regard to their uses in this city we shall speak more fully in another place.

Trinidad asphalt is imported and refined by the Warren Chemical and Manufacturing Company (45 John Street). This substance, as it occurs in nature, is very impure; about one third of the mass consists of water, another third is made up of clay and sand, so that only one third is actually bitumen. It is melted in large kettles and heated for twelve hours to expel the water, the earthy constituents settling to the bottom. This partially purified asphalt, which still contains about twenty per cent of impurities, is poured through a sieve into barrels, where it solidifies. It now forms a brittle mass, which sells for twenty-five dollars per ton. It is too hard for mixing with the pulverized asphalt-rock, or for street pavements. At Val de Travers and Seyssel the residues from the distillation of bituminous shale, known as "shale-grease," are used to soften it, while in other places similar residues of paraffine manufacture or petroleum refining are added to the natural bitumen to form what is known as "prepared bitumen," or mineral tar. In this country the so-called "still-bottoms" from petroleum-stills are used in the proportion of fifteen parts of the latter to eighty-five of the natural asphalt; the portions may be varied to suit the climate and other conditions.

Asphalt pavements may be divided into three classes. The first, which is commonly known as mastic (*asphalte coulé*), is best adapted to sidewalks, court-yards, and other places where there is but little heavy traffic. It is prepared by melting the blocks of mastic, already described, in caldrons, adding a small quantity of prepared bitumen, and afterward stirring in thirty or forty per cent of clear grit. When thoroughly mixed it is carried to the spot in pails, and spread with a wooden float by a skilled workman on his knees. It is then rubbed until perfectly smooth, and fine sand strewed over it. Examples of this pavement can be seen in Union Square, Tompkins Square, and several other places in New York city.

Compressed asphalt is better adapted to heavy traffic, as in street pavements, and is much employed in Paris. The powdered rock is used without any addition. It is applied hot, on a prepared bed of concrete, four to seven inches thick, and compressed, with heated rammers and a heated roller, to the thickness of one and a half or two inches. The smooth surface is given by a heated smoothing-iron. One block of compressed Val de Travers asphalt, two inches thick, laid on a Portland cement concrete foundation seven inches thick, may be seen on Fifth Avenue, between Twenty-sixth and Twenty-seventh Streets.

The third form of pavement, which seems to be one of the best for roadways, is the "Trinidad." It is made of prepared bitumen, i. e., Trinidad asphalt and still-bottoms, mixed with about twice its weight of calcareous marl or powdered limestone. None of the imported asphalt mastics or rock are used in this pavement.

Various imitations of both asphalt and mastic have been palmed off on the public, or substituted by dishonest contractors, some of whom will keep a few blocks of real mastic of a well-known brand lying about, as if they were to be used, while inferior materials are thrown into the caldrons. Some imitations are but little inferior to the genuine, while others are nearly worthless, and have done much to bring asphalt into disrepute. Among the latter are those made in whole or in part of the pitch left in the distillation of coal-tar. Although useful for a great variety of purposes, it will not answer for asphalt pavements. It is usually possible to distinguish good bitumen by its smell when warmed. When heated with excess of concentrated or fuming sulphuric acid for twenty-four hours, and then diluted and filtered, the pure natural bitumen yields a nearly colorless solution, but if pitch is present the solution will be dark-brown or black. Another distinction between real bitumen and coal-tar is found in the solubility of the latter in alcohol, the former being nearly insoluble. If a grain of material that has been heated to 200° C. is pulverized and mixed with 5 c. c. of strong alcohol, the latter will acquire a yellow color and bluish-green fluorescence if there is more than two per cent of pitch present.

There are several uses to which asphalt may be applied, the most important being the one already so often referred to, namely, as paving material. In Paris about thirty-three miles of street are covered with asphalt pavement, more than three fourths of it being the so-called "compressed asphalt," while the remainder is made of cast or mastic asphalt. The use of asphalt pavements for roadways began in Paris in 1854, since which time their use has been steadily increasing until the present time. In London there are about nine miles of asphalted streets. Asphalt pavements have but recently begun to find favor in Berlin, and at the close of 1881 there were only six miles of street paved with it. Of asphalt sidewalks, etc., Paris has three million square metres, equivalent to four hundred miles of walks, seventeen feet wide.

New York city can boast of only a few small and isolated strips of asphaltic street pavement, her past experience with the "poultice-pavement" having induced the authorities to prohibit the laying of similar pavements. In front of the Brevoort House, and the Hotel Brunswick, samples of compressed pavement may be seen, while the American mastic, or Trinidad, has recently been laid in Fifteenth Street, between Fifth and Sixth Avenues. In Washington, D. C., more than forty miles of the last-named pavement have been put down, and it is said to be doing good service. There are a large number of the mastic sidewalk and court-yard pavements in this city, some of which have already been referred to.

The advantages claimed for asphalt pavements are cleanliness, noiselessness, and durability, while the wear and tear of horses and wagons is less, and they are the pleasantest of all pavements to ride on. On the other hand, they are often slippery, and horses are liable to fall on them, while they are more difficult to repair when broken in digging for water and other pipes, although it is said that water-pipes are less liable to freeze under asphalt than under other pavements.

Asphalt does not emit sparks when struck with steel, and therefore is useful for the flooring of powder-magazines, and of casemates in fortifications.

As damp-proof coating for vaults and cellar-walls it is invaluable, for, not only does it shut out damp from below, but prevents unhealthy exhalations of the soil from entering the dwelling.

Asphalt has been used as flooring in stables, although there has been some complaint that it is cut by the stamping of the animals. It would seem to be an excellent material for the purpose, as it is unacted upon by urine, and, being without cracks, prevents the liquids from passing through and saturating the earth beneath. It is in use in the stables of the American Horse Exchange, Fifty-sixth Street and Broadway.

Asphalt floors have found more extensive use in breweries and sugar-refineries, for which they seem perfectly adapted. It is frequently applied to cellar-bottoms in city houses, some careful citizens having covered their cement floors with asphalt mastic.

A method of laying floors is much used in France, for barracks and hospitals, which would probably answer for many other purposes. Pieces of oak, usually two and a half to four inches broad, twelve to thirty inches long, and one inch thick, are pressed down into a layer of hot asphalt, not quite half an inch thick, in herring-bone pattern. The edges of the blocks are planed down, beveling toward the bottom, thus insuring adhesion to the asphalt, and the smallest possible joints.

A coarse sort of canvas saturated with bitumen is used to prevent dampness from rising through capillary attraction and penetrating the walls of buildings, especially light-houses and marine structures. It is made in strips twelve, sixteen, twenty, or twenty-four inches wide, to correspond with walls made of three, four, five, or six courses of brick. Its superiority to ordinary bitumen depends on the fact that it will not crack, like the latter, from unequal settling of the walls. Damp-resisting solutions are also sold for coating damp walls.

Asphalt mastic is much superior to tar for roofing purposes, owing to its *fire-proof* qualities, and its use for this purpose is rapidly increasing. At the present writing it is being applied to the Welles Building, at the lower end of Broadway. It is said that, when a building covered with such a roof burns, the falling roof acts like a blanket in smothering and extinguishing the flames.

Asphalt possesses another valuable property, that of absorbing vibrations, and is hence useful for foundations of machinery running at high speeds. A block of bituminous concrete weighing forty-five tons formed the foundation of the Carr's disintegrator which made fourteen hundred revolutions per minute at the Paris Exhibition. It would seem to be especially adapted to serve as foundations for the high-speed steam-engines used for generating electricity.

Asphalt forms an excellent insulator for electricity, but, as other and cheaper materials may be employed, its use will not be so extensive in this field.

The origin of asphalts is unknown, but several theories have been advanced in regard to it. Professor J. S. Newberry believes that they are the more or less perfectly solidified residual products of the spontaneous evaporation of petroleum. If we accept this theory (and many do not), we are but one step nearer a solution of the problem, for the origin of petroleum itself is still unknown. Some think that the bitumen was formed first, and the limestone deposited in it; others, that the liquid bitumen was forced into the pores of limestone already in existence; while a third hypothesis assumes that they were formed simultaneously, the bitumen from the organic matter, and the lime from the shells of some ancient mollusks. The last-named theory seems to have some support in the abundance of fossil ammonites met with in the mines at Limmer; the experimental attempts to impregnate the rock artificially, as above described, render the second hypothesis improbable, although its occurrence on the Dead Sea and in Trinidad is in its favor. No explosive gases are met with in the mines of Val de Travers, Seyssel, and Lobsann, so that open lights are used; but at Pechelbronn, a few miles from Lobsann, several explosions have occurred. Although these were attributed to marsh-gas, they were more probably due to the vapors of the lighter constituents of petroleum, with which the bituminous sands of that locality seem to be saturated.

There are several circumstances which indicate that bitumen and asphalt are more nearly related to petroleum than to coal-tar, and that, whether asphalt was made from petroleum or not, they have a similar or common origin. Nor is it an unfortunate circumstance that coal-tar can not be used as a substitute for bitumen, since the former contains many constituents that are more valuable for other purposes, while Trinidad offers an inexhaustible supply of the latter.

SPECULATIVE ZOÖLOGY.

By Professor W. K. BROOKS,
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I.

AT a time when most naturalists who venture at all beyond the facts of life-science are busied with the attempt to trace the relationship between the various groups of living things, and to express this relationship in a tree-like system of classification, it is startling to hear from one of the highest authorities on life-science the statement that "the time for genealogical trees is past. . . . It seems hardly credible that a school which boasts for its very creed a belief in nothing which is not warranted by common sense should descend to such trifling." *

It is true that the context seems to show that the author does not visit all attempts at phylogenetic classification with the sweeping condemnation which the passage quoted seems to imply, yet the fact that a high authority upon the subject has made such a statement at all is a sufficient reason why those who believe that the status of modern morphology is not without a basis of common sense should carefully revise their grounds for this belief, in order to decide for themselves how far, and in what shape, such speculations upon the relationships of organisms are admissible, and favorable to the progress of science.

The belief that the present life of the globe is only a very small part of its total fauna and flora is hardly more firmly fixed in the minds of the present generation of naturalists than the belief that the recent species are the modified descendants of those which are extinct; and there are few who would not acknowledge that their conception of the origin of life would be fairly illustrated by comparing the living things of the past and present to a great, many-branched tree, buried in the ground so that only a few scattered groups of twigs are exposed to our direct observation, although these groups show by their arrangement a vague and indefinite relation to the branches below the ground. The twigs which are exposed are the living things which now people the earth, and those twigs and branches and larger trunks which

* "Embryology and Paleontology," by Alexander Agassiz. Address before the American Association for the Advancement of Science.

are below-ground are those organisms which are buried in the past, and which we can study only through their fossil remains.

Most naturalists not only believe that, if we could trace back the history of life, we should find each group bearing evidence of wider and wider relationship as we receded from the present time, but they also believe that we should ultimately find that every form of life is related to every other in such a way as to show that, in the remote past, they all met in a single starting-point—the common ancestor of all living things.

When we come to examine the evidence for this theory of the common origin of all life, we find that it is almost entirely general in its character. There is a nearly complete absence of specific and definite proof. We find an abundance of fossil forms, which we may regard as connecting links between one great group of animals and another; but even in the most favorable cases the attempt to follow the history of any particular species back for a considerable length of time soon ends in a total failure, for we lose track of its line of descent entirely, and can go on only by substituting, for the species with which we started, the genus, family, or more comprehensive group to which we have traced it.

Once in a while we find, in the later geological formations, a fossil animal which exhibits such affinity to several closely related recent species, that there is a strong presumption that it is the common ancestor from which they have descended. We have enough evidence to enable us to trace the horse and its allies through several geological periods with considerable accuracy, and to reach a form which is widely different from the horse, and which shows relationship to quite different groups of recent mammals. There are a few other cases where the evidence is equally abundant; but more usually it fails completely, and, although the fossils of the later formations show a very close relationship to their living allies, the resemblance is not exact enough to prove that the fossil forms are the direct ancestors of the recent ones, rather than more distant relations, connected by some unknown fossil form.

In place of the exact evidence which would be necessary to prove that the nearest fossil allies of recent species are in the direct line of descent, we have only the vague general evidence which is furnished by those fossils which unite in themselves the characteristics of widely separated families, or classes, or orders of animals. While the attempt to trace any particular species of bird and any given species of reptile to a common ancestor would be hopeless, we do find fossil organisms in whose structure certain general characteristics of the class Birds are united to certain general characteristics of the class Reptiles, in the way which we might expect if those animals are the descendants of true reptiles and the ancestors of the true birds of the present day. There is no proof that this actually is the case, and it is perfectly possible that they are not in the direct line of descent at all. The evidence is entirely circumstantial and indefinite, and it is impossible to show that any of the reptile-like birds which have been discovered have any descendants at the present day. All we can say is that, if our birds are not their descendants, it is very probable that they are the descendants of some other unknown form very much like them.

At the best it is simply a question of probability, not of direct proof, and paleontological evidence is never definite enough to enable us to reach a specific conclusion which may not possibly be wrong, and, this being the state of the case, we may fairly ask whether such speculations upon probability, in the absence of direct evidence, are entitled to be called science. In order to answer this question, and to show that phylogenetic speculation may be strictly within the legitimate scope of science, we will make use of an imaginary illustration.

Suppose that a large continental area, which is inhabited by a homogeneous human race, is invaded by a band of settlers from another country, about as the first European settlers forced themselves upon the homogeneous inhabitants of the United States.

Suppose that these settlers, increasing in numbers, gradually spread over the whole country, interbreeding with the autochthones, until, in later generations, the population comes to consist of two equally distributed races, represented by individuals of pure descent, with strongly marked race-characteristics ; and, in addition to these, a great number of hybrids, presenting the characteristics of the two pure races in all degrees and manners of union.

As time goes on, imagine this latter class to increase at the expense of the others, until few persons of pure blood are left ; and meanwhile suppose that a number of persons of a third race are introduced, about as the negroes were introduced into this country, and, after this immigration has lasted for a time, suppose it to stop, and let this third race spread and increase, and, after a time, gradually mix with the other two. Let the same process take place again, until the population comes to be made up of four quite dissimilar races with well-marked race-characteristics, crossed in such a way that no individuals of the original race or of the first immigration are of perfectly pure blood, while there are a few nearly pure types of the third race, and still more of the fourth. Suppose, now, that an anthropologist undertakes to study the inhabitants of the country in order to learn what he can of their origin and history, and let him begin by attempting to classify them. Any attempt to divide them up into groups will fail, on account of the complexity of their relationships ; and, although there are traces of four types, it is not possible to arrange them in four classes, since most of them have resemblances to more than one type. After long study of their relationships, and an enumeration of all the forms which are distinguishable, we may suppose him to hit upon some such expedient for tabulating their resemblances as that of arranging them in four intersecting sets of concentric circles.

One type, the latest arrival, would be represented by a series of larger and larger circles around a center—the center standing for the few individuals of pure blood; the next ring, overlapping the other sets a little, would represent those persons, more numerous than the pure specimens, in whom the characteristics of the race are slightly obscured by characteristics of the other types. The next still larger ring, intersecting still more rings in the other sets, represents the still greater number of individuals of less pure descent, and so on; each larger circle, intersecting the other sets at more points, will represent the manner in which the number of individuals increases as the purity of the type disappears.

The race which has been a little longer in the country will, if it has been equally prolific, and equally inclined to mix with the others, be represented by a system with no center, but with a few very small rings so near the center that they have few points of intersection with the other sets—that is, there will be a few persons with nearly pure blood, but none of perfect purity. The two older races will be represented by systems which are made up entirely of large intersecting circles. After his studies have carried him thus far, we may suppose the anthropologist to speculate how or why it is that the complicated resemblances of this mixed people should follow a system which admits of such a peculiar system of tabulation. He might perhaps invent an hypothesis to explain it—the hypothesis of immigration. As this hypothesis would account for all his facts, there would be a probability in its favor sufficient to justify him in following it out as far as possible, to see what it would lead to, and we may suppose him to continue his studies historically. He would now find that the number of pure specimens of the race which entered the country last was greater a few generations back than at present, while the number of persons who exhibit only slight traces of the characteristics of this race become less numerous as he traces the history backward. Going still further back he would find that the pure-blooded specimens of this race not only become more numerous in proportion to those of mixed blood, but also more restricted in their distribution over the country.

Still farther back he would find records of the entrance of a few perfectly pure representatives of this race into the country, and, continuing his studies, he would meet with no evidence of the presence of any of them before this date.

Continuing his studies he would find that the second race gradually became more pure and more restricted, and, although he might not meet with any record of their first appearance except vague and contradictory traditions, he would find that there was no mention of them in any of the records before a certain date. The older monuments and records would contain references to only two races, and, although there might be no traditions to show that either of these had occupied the country longer than the other, the history of the language and the architectural and other remains would bear witness to the gradual introduction of one of them, and would show that in still more ancient times there were no traces of the existence of more than one race.

The interpretation of the relationships of the people to which he had been led by the study of the living inhabitants would now be far more than a working hypothesis, for everything which had been learned about their past history could be shown to be exactly what we should, by the hypothesis, expect, and he might therefore claim that this was a strictly scientific explanation of the theory of their origin. Although he would have definite proof of only one immigration, he would be fully warranted in concluding that the present inhabitants are the result of the crossing of four races; that at one time only one of these races inhabited the country, and that the other three have been introduced from outside at different times in a definite order.

The mass of evidence which he could bring forward in favor of this opinion would be sufficient to render it more probable than any other explanation of their origin, and would fully justify its acceptance as a scientific truth, but a little examination will show that the evidence is entirely circumstantial, and does not by any means amount to absolute proof, but only to a very great degree of probability. Although it may be true that it is very much more probable than any other explanation, this may be due to imperfect knowledge, and some other explanation may possibly be the true one.

In order to show this, let us suppose that the people of the country have another account of their origin, and believe that the four types were formed ages ago by the breaking up of an homogeneous race into four castes, which have ever since borne substantially the same relations to each other. Suppose that this belief bears such a relation to other traditions, and to certain manners and customs, that it has assumed, in their minds, a very great importance, and is regarded as a point of grave significance, resting upon irreproachable evidence. They might answer the anthropologist somewhat in this manner: You have certainly made out a very ingenious story, and have brought together a mass of evidence which appears to render your view very probable, but you have not shown that no other explanation is possible, and, as we do hold quite a different opinion upon evidence which is satisfactory to us, you must be mistaken. We are open to conviction, and are not unreasonable, but we must have proofs which leave no room for doubt, for as long as there is a chance that you are wrong we must hold to our old view. If you say that all natural knowledge is simply probable, and open to the possibility of error, give us proofs which are as direct as those which are furnished by the physical sciences, instead of the general and circumstantial evidence which you adduce. The student of physics does not ask us to believe that all bodies attract each other according to the law of inverse squares until he has shown us that he is able to prove that every body we bring him does behave in this way; and the chemist shows us that he can separate every specimen of pure water which we furnish into oxygen and hydrogen before he expects us to believe that all water is compounded of these two substances. This is the sort of proof we want; something exact and specific in place of your generalizations. When you can trace back the ancestry of any man we bring you with what you call negro characteristics, tell us who his father and grandfather were, and so on, until you reach one of your negro immigrants—when you can do this with all our inhabitants, and show us that every man with these characteristics is the descendant of one of these immigrants, and that every man with European characteristics has some of the blood of one of your European immigrants in his body, you may claim that you have given us scientific proof of your hypothesis.

If that is too much to ask, trace one of our people back in this way, for it must be plain to you that, if you are not able to do this, your hypothesis is only a probability.

You trace us back for a generation or two with some exactness, but then you make a great leap to some one whom you find mentioned in history, and you trace his ancestors and descendants for a generation or two, and then comes another break. There is no certainty that he has any living descendants, nor is there any certainty that he is at all related to any of your immigrants. We acknowledge your proofs of a negro immigration, and we know that a few other negroes have come to our country from time to time, but their race soon dies out, and you must remember that we have satisfactory evidence that our race had its present character long before the time when you say the foreign elements were introduced.

Even if we grant the accuracy of all the facts which you claim to have discovered, they only show that the history which you have traced out is such a history as your hypothesis would lead you to expect, but this does not prove the truth of the hypothesis. You have only got at a few facts here and there, and future discoveries may show that you are wrong. We are glad to know about the foreign settlers, but you have by no means proved that they were ancestors of ours.

I think that this illustration gives us a fair statement of the value of the evidence for evolution which is furnished by paleontology. There is an absolute and total lack of direct proof, and there must be by the nature of the case, so there is no room to hope for the conversion of any one who is determined to reject the theory as long as doubt is possible; but the end of science is not to proselyte but to discover, and the circumstantial evidence converges in such a way as to give in this case every assurance of substantial accuracy.

There is not a single wild species of animal which can be traced, by direct unbroken pedigree, to an ancestor belonging to a different genus, and no zoölogist has any hope of ever obtaining anything more than circumstantial evidence of such a pedigree; but we can hardly overestimate the vast and increasing stores of evidence in favor of evolution which are yielded by the structural, geographical, and chronological relations between the fauna of the present day and that of the past. It is true that all this evidence is circumstantial, and, although it renders the theory of evolution vastly more probable than any other explanation of the origin of species, it still leaves a possibility that some other explanation may be the true one. Although the investigator who is fully acquainted with all the evidence may feel justified in ignoring this possibility, it still exists.

If the evidence which we have is so circumstantial that it does not amount to absolute proof, it is clear that, even if we fully believe in evolution, we can not hope to trace, with anything like minute accuracy, the past history of any particular form of life; but perhaps an illustration may help to make this clearer:

Let the dots A, B, and C (Fig. 1), represent a number of recent species, each of which has distinctive characteristics of its own, together with other characteristics which are common to all; and let D, E, and F be another set of species related to each other in the same way; and suppose that certain of the common characteristics of D, E, and F are also common to A, B, and C, while others distinguish the one set as a whole from the other as a whole. According to the theory of evolution, we believe that A, B, and C are the descendants of an ancestor from whom they inherit all that they have in common; and that D, E, and F are related to each other in the same way; that the common ancestor of all the forms in the first group had, together with distinctive characteristics of its own, certain other characteristics which it shared with the ancestor of the forms in the second group, and that this similarity was due to inheritance from a still more remote ancestor common to both. This system of relationship might be expressed by a phylogenetic tree, like that which is shown by dotted lines ..... in the diagram, with six ultimate ramules, two large branches, and a common stem, G. Now, suppose that we discover, in a recent geological formation, a fossil form, M, which resembles A, B, C, D, E, and F in all the features which they have in common. It is possible that this fossil is the form G, from which A, B, C, D, E, and F are descended, but it is not probable that this is the case, for the analogy of recent species compels us to believe that the fossil M was one of several closely related species, G, H, I, K, and L, any one of which may have been the ancestor of the recent forms, and, as M is only one out of several species, the chances are that it is not the root G from which

A, B, C, D, E, and F are descended. Even if it could be proved to be the only species of its genus, and therefore the direct ancestor of the recent species, the precise manner in which these are related to it would still remain in uncertainty, for it may have given rise, at about the same time, to two divergent variations, represented by the dotted lines, and these may have led to the two forms *a* and *b*, each of which gave rise to variations which resulted in the recent species A, B,

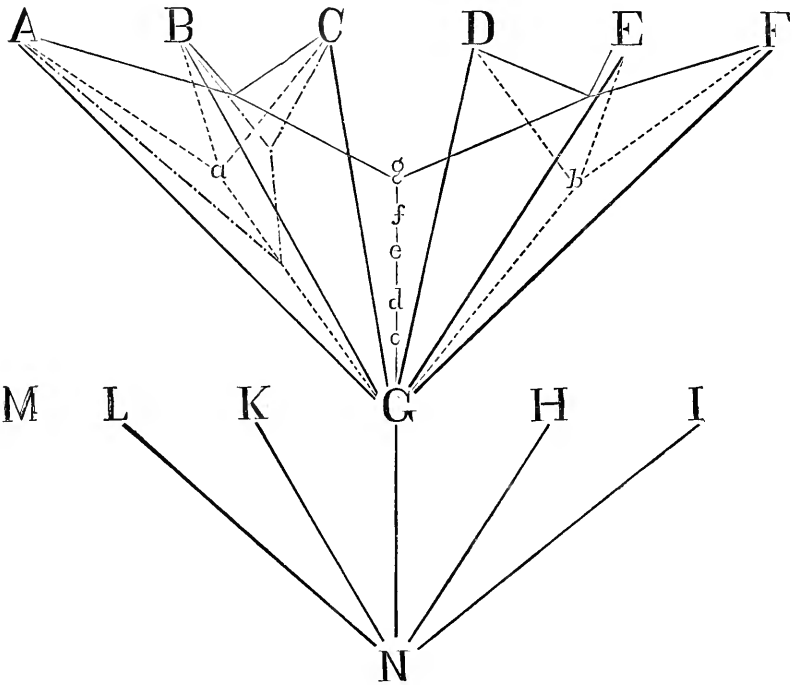

FIG. 1

C, and D, E, F, or it may have persisted for a long time, and become slowly modified, through the stages *c*, *d*, *e*, *f*, into the form *g*, different from the form G, and still more different from the known fossil M, before it gave rise to the ancestors of the two recent genera. In this case the phylogenetic tree would be represented by the continuous light lines of the diagram. It is possible, again, that A, B, and C are not equally related, but that two of them, B and C, for instance, have had a common ancestor which was not in the line which led to A, and in this case their relationships would be expressed by the broken lines —.—.—.— of the diagram; or, finally, it is perfectly possible, and many naturalists think it is very probable, that evolution has been guided by some more fundamental law than that of the natural selection of divergent variations, and, if this is so, the characteristics which distinguish A, B, and C may be due to something else than descent from a common ancestor, *a*, different from the common ancestor *b* of D, E, and F, and all may be the descendants of G, in the way shown by the heavy lines, or A may be the descendant of I; B of K; C of G, etc. If we were to attempt to indicate all the possible ways in which the six living species, A, B, C, D, E, and F, may be related to the fossil M, the diagram would become a confused mass of lines, and we have pointed out enough to show that, in a very simple case, where there are only two living genera and only six species, the attempt to follow them back only two stages to a common ancestor leads to so many possible systems of relationship that there is a very great chance against the truthfulness of any particular one, and we may fairly ask whether the attempt to express the relationships of animals in a tree-like classification can have any scientific value if the chances against its correctness are so very great. At first sight it may seem as if no good could be expected from this sort of speculation, and we may feel inclined to condemn the construction of phylogenetic trees as unscientific; but a little examination will show that all the lines in the diagram agree in one important particular, and trace the recent animals, A, B, C, D, E, and F, back to a remote common ancestor with a general resemblance to M. This, after all, is the essential thing, the gist of the whole matter, for the precise line of descent has no more scientific interest than the exact pedigree of each person would have to the anthropologist of our illustration. Such an exact pedigree would have a certain value as a bit of specific information, but the general evidence is of such a character that it is more logical to accept the conclusion than it is to reject it, and it is as truly scientific as the conclusion of our anthropologist.

We find that living things are related to each other in a peculiar way, which can be explained upon the assumption that they are the modified descendants of more ancient generalized forms, with wider relationships, and this assumption can be readily expressed in the form of a phylogenetic tree. We find, too, that so far as the higher groups of vertebrates, the mammals, reptiles, and birds, are concerned—groups which are of comparatively recent appearance, like the last races of immigrants in our imaginary case—the fossil forms which we meet with are such as our assumption would lead us to expect. The presumption is, therefore, very great that the genetic relations of living things may be expressed with general accuracy by a phylogenetic tree, although the chances of minute accuracy of detail in favor of any particular tree which is drawn up from paleontological evidence are very slight. This lack of minute accuracy can not be urged as an objection to all attempts at following out, in a general way, the lines of evolution of our present groups of animals, according to the best evidence which is attainable, and we must remember that only a very small part of this evidence is furnished by paleontology. If no fossils were known, the facts of comparative anatomy, of embryology, and of geographical distribution would be enough to satisfy us that the living things known to us are the divergent descendants of more generalized ancestors, and that their relationships can be most exactly expressed by a system of converging lines, which meet and form larger branches to represent the extinct ancestors from which our divergent species are descended. The evidence is circumstantial, and only leads to general conclusions, and a complete series of fossil forms is the only absolute proof which we could have; but, in the absence of this proof, the conclusions drawn from the study of living animals are rendered extremely probable by the fact that the fossil members of the more modern groups of animals, such as the mammals and birds, are just such forms as the evidence from other sources leads us to expect, and the attempt to read and interpret such records as we have, and to trace the history of life with as much accuracy as possible, is therefore perfectly legitimate, and may fairly claim the attention of the morphologist.

ANNUAL GROWTH OF TREES.

By A. L. CHILD, M. D.

ARE the concentric rings of a tree a reliable record of its age in years? Such has been the conception—in fact, the undisputed knowledge—of the world, for all time past. I have no recollection of ever having seen or heard the authority of this record disputed till Désiré Charnay, in his "Ruins of Central America," said, when speaking of the age of the ruins as proved by such a record: "Unfortunately for the argument, it is altogether fallacious and proves nothing. I have put the evidence to a test. On examining a slice of wood of a shrub that I knew as a fact was only eighteen months old, I found that it had eighteen concentric rings. I thought it was an anomaly, but, in order to convince myself, I experimented upon trees of all kinds and sizes, and invariably found the like result produced in very nearly like proportions."*

M. Charnay's statement was, in my estimation, rather loose, and lacking in the proof of his absolute knowledge of the age of the trees examined; and again, so far as applicable to the case, was only so in a tropical climate, where the conditions were entirely different from those surrounding us in a higher latitude, and altogether raised but little doubt on the subject.

In April of 1871 I planted a quantity of the seed of the common red maple (*Acer rubrum*). In transplanting, in 1873, they were placed too near each other, and it has become necessary to cut a part

* "North American Review," September, 1881, p. 401.

of them out. While cutting, I noticed that the concentric rings were very distinct, and it reminded me of M. Charnay's statement. I took sections from the butt-end of each tree (four of them) and dressed the ends off, at an angle of some 35° with the line of the body, thus largely increasing the exposure of each ring, and then counted them.

The situation, exposure, and condition of these four trees were, so far as I could see, identical. I had personal and positive knowledge that they had each twelve years' growth upon them, and I could count on each of the different sections from thirty-five to forty concentric rings. True, I could select twelve more distinct ones between which fainter and narrower, or sub-rings, appeared. Nine of these apparently annual rings on one section were peculiarly distinct, much more so than any of the sub-rings; yet, of the remaining, it was difficult to decide which were annual and which were not.

The thickness of these annual rings varied from two and one half millimetres to twenty-eight. This measure, of course, gave more than double the real thickness; but was preferable to a right-angled measure, as it gave better facilities for exactness, and yet preserved the proportion between the several rings unchanged.

Now, to ascertain what relation or connection there might be between the meteorology of

YEAR.	MARCH. Maximum temperature.	MARCH. Minimum temperature.	MARCH. Mean temperature.	MARCH. Rain-fall.	APRIL. Maximum temperature.	APRIL. Minimum temperature.	APRIL. Mean temperature.	APRIL. Rain-fall.	MAY. Maximum temperature.	MAY. Minimum temperature.	MAY. Mean temperature.	MAY. Rain-fall.
	Deg.	Deg.	Deg.	In.	Deg.	Deg.	Deg.	In.	Deg.	Deg.	Deg.	In.
1871	...	...	42·80	·40	...	...	59·60	1·80	...	...	66·80	2·40
1872	...	...	32·70	1·40	...	...	47·70	2·40	...	...	57·10	4·40
1873	74	—4	36·37	·70	78	26	45·22	15·90	89	41	59·11	19·00
1874	60	7	32·15	2·51	88	12	44·65	4·09	92	38	67·48	3·15
1875	72	—3	29·11	3·38	84	20	44·81	4·62	96	25	71·00	3·98
1876	60	—4	27·92	2·09	83	30	51·12	5·16	88	35	63·73	3·10
1877	75	0	32·46	1·01	79	22	49·27	5·88	84	35	59·06	7·57
1878	81	19	16·74	3·09	83	31	53·95	4·01	81	32	57·49	5·54
1879	85	1	40·78	2·15	80	12	52·32	2·17	91	34	65·84	5·94
1880	82	—16	36·24	·56	93	28	52·26	·74	91	42	69·41	5·68
1881	58	1	26·63	1·31	81	4	43·70	4·09	85	39	67·03	6·57
1882	80	2	39·16	1·11	86	29	50·76	3·92	82	34	54·85	4·49

YEAR.	JUNE. Maximum temperature.	JUNE. Minimum temperature.	JUNE. Mean temperature.	JUNE. Rain-fall.	JULY. Maximum temperature.	JULY. Minimum temperature.	JULY. Mean temperature.	JULY. Rain-fall.	AUGUST. Maximum temperature.	AUGUST. Minimum temperature.	AUGUST. Mean temperature.	AUGUST. Rain-fall.	Mean temperature of six months.	Total rain of six months.	Growth of wood in millimetres.
	Deg.	Deg.	Deg.	In.	Deg.	Deg.	Deg.	In.	Deg.	Deg.	Deg.	In.	Deg.	In.	
1871	...	...	76·60	2·30	...	...	76·40	14·10	...	...	74·60	3·30	65·81	24·30	10
1872	...	...	73·06	4·70	...	...	75·17	7·40	...	...	74·53	·90	55·57	20·70	10
1873	94	60	75·08	4·80	96	59	75·54	6·40	105	49	77·98	1·00	61·00	46·99	12
1874	94	44	74·31	18·02	113	55	82·35	1·10	111	53	78·71	1·40	63·32	30·37	7
1875	95	43	71·20	13·58	97	57	74·13	6·72	86	51	69·68	8·40	63·71	40·68	28
1876	94	44	68·63	4·58	95	54	75·71	7·44	92	51	74·18	8·39	60·33	30·76	8
1877	90	40	67·45	6·41	94	48	73·34	2·20	94	52	71·75	4·56	59·08	27·72	7
1878	86	44	66·39	9·64	94	55	76·91	11·61	95	52	75·27	1·23	66·33	35·12	4
1879	90	41	70·51	5·05	94	56	75·84	3·10	94	50	73·71	2·16	63·18	20·57	3½
1880	92	45	71·80	1·57	93	51	75·19	4·73	95	41	74·00	5·42	61·47	18·70	8
1881	96	50	73·32	3·99	98	54	76·45	3·68	102	58	78·90	1·42	61·03	21·04	3
1882	92	43	69·23	5·77	89	48	68·48	4·26	88*	48	70·77	1·26	56·18	20·81	2½

* Only twenty days of August included.

the several seasons and the growth made during the same, I selected from my meteorological records the maximum, minimum, and mean temperature, and the rain-fall, of the six growing months of spring and summer of each of the twelve years of growth. These extracts I have tabulated, and have also appended to each season the thickness of the ring formed, as measured on the oblique cut previously described.

An examination of this table shows a general relation of cause and effect between high temperature and large rain-fall, and greater growth. But it falls very far short of proving a general law of "so much heat and so much water during the growing season, to produce so much wood." For example, compare the years 1875 and 1878. The temperature of 1878 for the season is better than 4° in excess of the season of 1875, and the rain-fall only a little over four inches less; and yet the growth of 1875 is *seven times* what it was in 1878. This almost unparalleled growth of 1875—that is, as compared with the other years—can not be explained by the above general law. But I think the May and June record of that year throws light upon it. We see there a maximum heat in May of 96° (higher than I have ever known it in an observation and record of twenty-five years), and a mean temperature of the whole month, also unequaled, of 71°; and this great heat continued through the month of June, and no cold spells after the heat set in sufficient to check the growth. Then, in connection with this heat, the ground was well saturated with water when this heated term began (May 6th) by 1·62 inch of rain on the 4th. From this on, to the 26th of June, 15 inches more of rain fell, so apportioned over the time as to keep the ground saturated. This synchronous excess of heat and water evidently produced the abnormal growth. And probably, as this matter is further studied, it will be found that these agents, rightly proportioned, operating synchronously, produce these thicker rings; while as one or the other is in excess, or absent, the growth is checked, and thus has time to condense and harden, and form these sub-rings; and the more frequent these alternations, the greater the number of them.

SCIENCE IN RELATION TO THE ARTS.

By C. WILLIAM SIEMENS, F. R. S.

II.

GAS is an institution of the utmost value to the artisan; it requires hardly any attention, is supplied upon regulated terms, and gives with what should be a cheerful light a genial warmth, which often saves the lighting of a fire. The time is, moreover, not far distant, I venture to think, when both rich and poor will largely resort to gas as the most convenient, the cleanest, and the cheapest of heating agents, and when raw coal will be seen only at the colliery or the gas-works. In all cases where the town to be supplied is within say thirty miles of the colliery, the gas-works may with advantage be planted at the mouth, or still better at the bottom of the pit, whereby all haulage of fuel would be avoided, and the gas, in its ascent from the bottom of the colliery, would acquire an onward pressure sufficient probably to impel it to its destination. The possibility of transporting combustible gas through pipes for such a distance has been proved at Pittsburg, where natural gas from the oil district is used in large quantities.

The *quasi* monopoly so long enjoyed by gas companies has had the inevitable effect of checking progress. The gas being supplied by meter, it has been seemingly to the advantage of the companies to give merely the prescribed illuminating power, and to discourage the invention of economical burners, in order that the consumption might reach a maximum. The application of gas for heating purposes has not been encouraged, and is still made difficult, in consequence of the objectionable practice of reducing the pressure in the mains during day-time to the lowest possible point consistent with prevention of atmospheric indraught. The introduction of the electric light has convinced gas managers and directors that such a policy is no longer tenable, but must give way to one of technical progress ; new processes for cheapening the production and increasing the purity and illuminating power of gas are being fully discussed before the Gas Institute ; and improved burners, rivaling the electric light in brilliancy, greet our eyes as we pass along our principal thoroughfares.

Regarding the importance of the gas-supply as it exists at present, we find from a government return that the capital invested in gas-works in England, other than those of local authorities, amounts to £30,000,000 ; in these, 4,281,048 tons of coal are converted annually, producing 43,000,000,000 cubic feet of gas, and about 2,800,000 tons of coke ; whereas the total amount of coal annually converted in the United Kingdom may be estimated at 9,000,000 tons, and the by-products therefrom at 500,000 tons of tar, 1,000,000 tons of ammonia liquor, and 4,000,000 tons of coke, according to the returns kindly furnished me by the managers of many of the gas-works and corporations. To these may be added say 120,000 tons of sulphur, which up to the present time is a waste product.

Previous to the year 1856—that is to say, before Mr. W. H. Perkin had invented his practical process, based chiefly upon the theoretical investigations of Hoffman, regarding the coal-tar bases and the chemical constitution of indigo—the value of coal-tar in London was scarcely a halfpenny a gallon, and in country places gas-makers were glad to give it away. Up to that time the coal-tar industry had consisted chiefly in separating the tar by distillation into naphtha, creosote, oils, and pitch. A few distillers, however, made small quantities of benzene, which had been first shown—by Mansfield, in 1849—to exist in coal-tar naphtha mixed with toluene, cumene, etc. The discovery, in 1856, of the mauve or aniline purple gave a great impetus to the coal-tar trade, inasmuch as it necessitated the separation of large quantities of benzene, or a mixture of benzene and toluene, from the naphtha. The trade was further increased by the discovery of the magenta or rosaniline dye, which required the same products for its preparation. In the mean time, carbolic acid was gradually introduced into commerce, chiefly as a disinfectant, but also for the production of coloring-matter.

The next most important development arose from the discovery by Graebe and Liebermann that alizarine, the coloring principle of the madder-root, was allied to anthracene, a hydrocarbon existing in coal-tar. The production of this coloring-matter from anthracene followed, and is now one of the most important operations connected with tar-distilling. The success of the alizarine made in this manner has been so great that it has almost entirely superseded the use of madder, which is now cultivated to only a comparatively small extent. The most important coloring-matters recently introduced are the azo-scarlets. They have called into use the coal-tar hydrocarbons, xylene and cumene. Naphthalene is also used in their preparation. These splendid dyes have replaced cochineal in many of its applications, and have thus seriously interfered with its use. The discovery of artificial indigo by Professor Baeyer is of great interest. For the preparation of this coloring-matter toluene is required. At present artificial indigo does not compete seriously with the natural product; but, should it eventually be prepared in quantity from toluene, a further stimulus will be given to the coal-tar trade.

The color industry utilizes even now practically all the benzene, a large proportion of the solvent naphtha, all the anthracene, and a portion of the naphthaline resulting from the distillation of coal-tar; and the value of the coloring-matter thus produced is estimated by Mr. Perkin at £3,350,000.

The demand for ammonia may be taken as unlimited, on account of its high agricultural value as a manure; and, considering the failing supply of guano and the growing necessity for stimulating the fertility of our soil, an increased production of ammonia may be regarded as a matter of national importance, for the supply of which we have to look almost exclusively to our gas-works. The present production of 1,000,000 tons of liquor yields 95,000 tons of sulphate of ammonia, which, taken at £20 10*s.* a ton, represents an annual value of £1,947,000.

The total annual value of the gas-works by-products may be estimated as follows:

Coloring-matter	£3,350,000
Sulphate of ammonia	1,947,000
Pitch (325,000 tons)	365,000
Creosote (25,000,000 gallons)	208,000
Crude carbolic acid (1,000,000 gallons)	100,000
Gas-coke, 4,000,000 tons (after allowing 2,000,000 tons consumption in working the retorts) at 12*s*.	2,400,000
Total	£8,370,000

Taking the coal used, 9,000,000 tons at 12*s*., equal £5,400,000, it follows that the by-products exceed in value the coal used by very nearly £3,000,000.

In using raw coal for heating purposes these valuable products are not only absolutely lost to us, but in their stead we are favored with those semi-gaseous by-products in the atmosphere too well known to the denizens of London and other large towns as smoke. Professor Roberts has calculated that the soot in the pall hanging over London on a winter's day amounts to fifty tons, and that the carbonic oxide, a poisonous compound, resulting from the imperfect combustion of coal, may be taken as at least five times that amount. Mr. Aitken has shown, moreover, in an interesting paper communicated to the Royal Society of Edinburgh, last year, that the fine dust resulting from the imperfect combustion of coal is mainly instrumental in the formation of fog; each particle of solid matter attracting to itself aqueous vapor; these globules of fog are rendered particularly tenacious and disagreeable by the presence of tar-vapor, another result of imperfect combustion of raw fuel, which might be turned to much better account at the dye-works. The hurtful influence of smoke upon public health, the great personal discomfort to which it gives rise, and the vast expense it indirectly causes through the destruction of our monuments, pictures, furniture, and apparel, are now being recognized, as is evinced by the success of recent Smoke Abatement Exhibitions. The most effectual remedy would result from a general recognition of the fact that, wherever smoke is produced, fuel is being consumed wastefully, and that all our calorific effects, from the largest down to the domestic fire, can be realized as completely and more economically, without allowing any of the fuel employed to reach the atmosphere unburnt. This most desirable result may be effected by the use of gas for all heating purposes, with or without the addition of coke or anthracite.

The cheapest form of gas is that obtained through the entire distillation of fuel in such gas-producers as are now largely used in working the furnaces of glass, iron, and steel works; but gas of this description would not be available for the supply of towns owing to its bulk, about two thirds of its volume being nitrogen. The use of water-gas, resulting from the decomposition of steam in passing through a hot chamber filled with coke, has been suggested, but this gas is also objectionable, because it contains, besides hydrogen, the poisonous and inodorous gas, carbonic oxide, the introduction of which into dwelling-houses could not be effected without considerable danger. A more satisfactory mode of supplying heating separately from illuminating-gas would consist in connecting the retort at different periods of the distillation with two separate systems of mains for the delivery of the respective gases. Experiments made some years ago by Mr. Ellisen, of the Paris gas-works, have shown that the gases rich in carbon, such as olefiant and acetylene, are developed chiefly during an interval of time, beginning half an hour after the commencement and terminating at half the whole period of distillation, while during the remainder of the time, marsh gas and hydrogen are chiefly developed, which, while possessing little illuminating power, are most advantageous for heating purposes. By resorting to improved means of heating the retorts with gaseous fuel, such as have been in use at the Paris gas-works for a considerable number of years, the length of time for effecting each distillation may be shortened from six hours, the usual period in former years, to four, or even three hours, as now practiced at Glasgow and elsewhere. By this means a given number of retorts can be made to produce, in addition to the former quantity of illuminating-gas of superior quality, a similar quantity of heating-gas, resulting in a diminished cost of production and an increased supply of the valuable by-products previously referred to. The quantity of both ammonia and heating-gas may be further increased by the simple expedient of passing a streamlet of steam through the heated retorts toward the end of each operation, whereby the ammonia and hydrocarbons still occluded in the heated coke will be evolved, and the volume of heating-gas produced be augmented by the products of decomposition of the steam itself. It has been shown that gas may be used advantageously for domestic purposes with judicious management even under present conditions, and it is easy to conceive that its consumption for heating would soon increase, perhaps tenfold, if supplied separately at say one shilling a thousand cubic feet. At this price gas would be not only the cleanest and most convenient, but also the cheapest form of fuel, and the enormous increase of consumption, the superior quality of the illuminating-gas obtained by selection, and the proportionate increase of by-products, would amply compensate the gas company or corporation for the comparatively low price of the heating-gas.

The greater efficiency of gas as a fuel results chiefly from the circumstance that a pound of gas yields in combustion twenty-two thousand heat-units, or exactly double the heat produced in the combustion of a pound of ordinary coal. This extra heating power is due partly to the freedom of the gas from earthy constituents, but chiefly to the heat imparted to it in effecting its distillation. Recent experiments with gas-burners have shown that in this direction also there is much room for improvement.

The amount of light given out by a gas-flame depends upon the temperature to which the particles of solid carbon in the flame are raised, and Dr. Tyndall has shown that, of the radiant energy set up in such a flame, only the $\frac{1}{25}$ part is luminous; the hot products of combustion carry off at least four times as much energy as is radiated, so that not more than one hundredth part of the heat evolved in combustion is converted into light. This proportion could be improved, however, by increasing the temperature of combustion, which may be effected either by intensified air-currents or by regenerative action. Supposing that the heat of the products of combustion could be communicated to metallic surfaces, and be transferred by conduction or otherwise to the atmospheric air supporting combustion in the flame, we should be able to increase the temperature accumulatively to any point within the limit of dissociation; this limit may be fixed at about 2,300° C., and can not be very much below that of the electric arc. At such a temperature the proportion of luminous rays to the total heat produced in combustion would be more than doubled, and the brilliancy of the light would at the same time be greatly increased. Thus improved, gas-lighting may continue its rivalry with electric lighting both as regards economy and brilliancy, and such rivalry must necessarily result in great public advantage.

In the domestic grate radiant energy of inferior intensity is required, and I for one do not agree with those who would like to see the open fire-place of this country superseded by the Continental stove. The advantages usually claimed for the open fire-place are, that it is cheerful, "pokable," and conducive to ventilation; but to these may be added another of even greater importance, viz., that the radiant heat which it emits passes through the transparent air without warming it, and imparts heat only to the solid walls, floor, and furniture of the room, which are thus constituted the heating surfaces of the comparatively cool air of the apartments in contact with them. In the case of stoves, the heated air of the room causes deposit of moisture upon the walls in heating them, and gives rise to mildew and germs injurious to health. It is, I think, owing to this circumstance that upon entering an apartment one can immediately perceive whether or not it is heated by an open fire-place; nor is the unpleasant sensation due to stove-heating completely removed by mechanical ventilation; there is, moreover, no good reason why an open fire-place should not be made as economical and smokeless as a stove or hot-water apparatus.

In the production of mechanical effect from heat, gaseous fuel also presents most striking advantages, as will appear from the following consideration. When we have to deal with the question of converting mechanical into electrical effect, or *vice versa*, by means of the dynamo-electrical machine, we have only to consider what are the equivalent values of the two forms of energy, and what precautions are necessary to avoid losses by the electrical resistance of conductors and by friction. The transformation of mechanical effect into heat involves no losses except those resulting from imperfect installation, and these may be so completely avoided that Dr. Joule was able by this method to determine the equivalent values of the two forms of energy. But, in attempting the inverse operation of effecting the conversion of heat into mechanical energy, we find ourselves confronted by the second law of thermo-dynamics, which says that, whenever a given amount of heat is converted into mechanical effect, another but variable amount descends from a higher to a lower potential, and is thus rendered unavailable.

In the condensing steam-engine this waste heat comprises that communicated to the condensing-water, while the useful heat, or that converted into mechanical effect, depends upon the difference of temperature between the boiler and condenser. The boiler-pressure is limited, however, by considerations of safety and convenience of construction, and the range of working temperature rarely exceeds 120° C., except in the engines constructed by Mr. Perkins, in which a range of 160° C., or an expansive action commencing at fourteen atmospheres, has been adopted with considerable promise of success, as appears from an able report on this engine by Sir Frederick Bramwell. To obtain more advantageous primary conditions we have to turn to the caloric or gas-engine, because in them the co-efficient of efficiency, expressed by $\frac{T-T'}{T}$, may be greatly increased. This value would reach a maximum if the initial absolute temperature T could be raised to that of combustion, and T′ reduced to atmospheric temperature, and these maximum limits can be much more nearly approached in the gas-engine worked by a combustible mixture of air and hydrocarbons than in the steam-engine.

Assuming, then, in an explosive gas-engine a temperature of 1,500° C., at a pressure of four atmospheres, we should, in accordance with the second law of thermo-dynamics, find a temperature after expansion to atmospheric pressure of 600° C., and therefore a working range of $1500° - 600° = 900°$, and a theoretical efficiency of $\frac{900}{1,500 + 274}$ = about one half, contrasting very favorably with that of a good expansive condensing steam-engine, in which the range is $150 - 30 = 120°$ C., and the efficiency $\frac{120}{150 + 274} = \frac{2}{7}$. A good expansive steam-engine is therefore capable of yielding as mechanical work two-seventh part of the heat communicated to the boiler, which does not include the heat lost by imperfect combustion, and that carried away in the chimney. Adding to these the losses by friction and radiation in the engine, we find that the best steam-engine yet constructed does not yield in mechanical effect more than one seventh part of the heat-energy residing in the fuel consumed. In the gas-engine we have also to make reductions from the theoretical efficiency, on account of the rather serious loss of heat by absorption into the working cylinder, which has to be cooled artificially in order to keep its temperature down to a point at which lubrication is possible; this, together with frictional loss, can not be taken at less than one half, and reduces the factor of efficiency of the engine to one fourth.

It follows from these considerations that the gas or caloric engine combines the conditions most favorable to the attainment of maximum results, and it may reasonably be supposed that the difficulties still in the way of their application on a large scale will gradually be removed. Before many years have elapsed we shall find in our factories and on board our ships engines with a fuel-consumption not exceeding one pound of coal per effective horse-power per hour, in which the gas-producer takes the place of the somewhat complex and dangerous steam-boiler. The advent of such an engine and of the dynamo-machine must mark a new era of material progress at least equal to that produced by the introduction of steam-power in the early part of our century. Let us consider what would be the probable effect of such an engine upon that most important interest of this country—the merchant navy.

According to returns kindly furnished me by the Board of Trade and "Lloyd's Register of Shipping," the total value of the merchant shipping of the United Kingdom may be estimated at £126,000,000, of which £90,000,000 represent steamers having a net tonnage of 3,003,988 tons; and £36,000,000 sailing-vessels, of 3,688,008 tons. The safety of this vast amount of shipping, carrying about five sevenths of our total imports and exports, or £500,000,000 of goods in the year, and of the more precious lives connected with it, is a question of paramount importance. It involves considerations of the most varied kind: comprising the construction of the vessel itself, and the material employed in building it; its furniture of engines, pumps, sails, tackle, compass, sextant, and sounding apparatus, the preparation of reliable charts for the guidance of the navigator, and the construction of harbors of refuge, light-houses, beacons, bells, and buoys, for channel navigation. Yet notwithstanding the combined efforts of science, inventive skill, and practical experience—the accumulation of centuries—we are startled with statements to the effect that during last year as many as 1,007 British-owned ships were lost, of which fully two thirds were wrecked upon our shores, representing a total value of nearly £10,000,000. Of these ships 870 were sailing-vessels and 137 steamers, the loss of the latter being in a fourth of the cases attributable to collision. The number of sailing-vessels included in these returns being 19,325, and of steamers 5,505, it appears that the steamer is the safer vessel, in the proportion of 4·43 to 3·46; but the steamer makes on an average three voyages for one of the sailing-ship taken over the year, which reduces the relative risk of the steamer as compared with the sailing-ship per voyage in the proportion of 13·29 to 3·46. Commercially speaking, this factor of safety in favor of steam-shipping is to a great extent counterbalanced by the value of the steamship, which bears to that of the sailing-vessel per net carrying ton the proportion of 3 : 1, thus reducing the ratio in favor of steam-shipping as 13·29 to 10·38, or in round numbers as as 4 : 3. In testing this result by the charges of premium for insurance, the variable circumstances of distance, nature of cargo, season, and voyage have to be taken into account; but, judging from information received from ship-owners and underwriters of undoubted authority, I find that the relative insurance paid for the two classes of vessel represents an advantage of 30 per cent in favor of steam-shipping, agreeing very closely with the above deductions derived from statistical information.

In considering the question how the advantages thus established in favor of steam-shipping could be further improved, attention should be called in the first place to the material employed in their construction. A new material was introduced for this purpose by the Admiralty in 1876–'78, when they constructed at Pembroke dock-yard the two steam corvettes, the Iris and Mercury, of mild steel. The peculiar qualities of this material are such as have enabled ship-builders to save 20 per cent in the weight of the ship's hull, and to increase to that extent its carrying capacity. It combines, with a strength of thirty per cent superior to that of iron, such extreme toughness, that in the case of collision the side of the vessel has been found to yield or bulge several feet without showing any signs of rupture, a quality affecting the question of sea-risk very favorably. When to the use of this material there are added the advantages derived from a double bottom, and from the division of the ship's hold by means of bulk-heads of solid construction, it is difficult to conceive how such a vessel could perish by collision either with another vessel or with a sunken rock. The spaces between the two bottoms are not lost, because they form convenient chambers for water-ballast, but powerful pumps should in all cases be added to meet emergencies.

The following statement of the number and tonnage of vessels building and preparing to be built in the United Kingdom on the 30th of June last, which has been kindly furnished me by Lloyd's, is of interest as showing that wooden ships are fast becoming obsolete, and that even iron is beginning to yield its place, both as regards steamers and sailing-ships, to the new material mild steel; it also shows that by far the greater number of vessels now building are ships of large dimensions propelled by engine-power:

	MILD STEEL.		IRON.		WOOD.		TOTAL.	
	No.	Tons gross.	No.	Tons gross.	No.	Tons gross.	No.	Tons gross.
Steam..........	89	159,751	555	929,921	6	460	650	1,090,132
Sailing.........	11	16,800	70	120,259	49	4,635	130	141,694
	100	176,551	625	1,050,180	55	5,095	780	1,232,826

If to the improvements already achieved could be added an engine of half the weight of the present steam-engine and boilers, and working with only half the present expenditure of fuel, a further addition of 30 per cent could be made to the cargo of an Atlantic propeller vessel—no longer to be called a steamer—and the balance of advantages in favor of such vessels would be sufficient to restrict the use of sailing-craft chiefly to the regattas of this and neighboring ports.

The admirable work on the "British Navy," lately published by Sir Thomas Brassey, the Civil Chief Lord of the Admiralty, shows that the naval department of this country is fully alive to all improvements having regard to the safety as well as to the fighting qualities of her Majesty's ships of war, and recent experience goes far to prove that, although high speed and manœuvring qualities are of the utmost value, the armor-plate which appeared to be fast sinking in public favor is not without its value in actual warfare.

The progressive views perceptible in the construction of the navy are further evidenced in a remarkable degree in the hydrographic department. Captain Sir Frederick Evans, the hydrographer, and Vice-President of the British Association, gave us at York last year a very interesting account of the progress made in that department, which, while dealing chiefly with the preparation of charts showing the depth of water, the direction and force of currents, and the rise of tides near our shores, contains also valuable statistical information regarding the more general questions of the physical conditions of the sea, its temperature at various depths, its flora and fauna, as also the rain-fall, and the nature and force of prevailing winds. In connection with this subject the American Naval Department has taken an important part, under the guidance of Captain Maury and the Agassiz father and son, while in this country the persistent labors of Dr. William Carpenter deserve the highest consideration.

Our knowledge of tidal action has received a most powerful impulse through the invention of a self-recording gauge and tide-predicter, which will form the subject of one of the discourses to be delivered at our present meeting by its principal originator, Sir William Thomson; when I hope he will furnish us with an explanation of some extraordinary irregularities in tidal records, observed some years ago by Sir John Coode at Portland, and due apparently to atmospheric influence.

The application of iron and steel in naval construction rendered the use of the compass for some time illusory, but in 1839 Sir George Airy showed how the errors of the compass, due to the influence experienced from the iron of the ship, may be perfectly corrected by magnets and soft iron placed in the neighborhood of the binnacle, but the great size of the needles in the ordinary compasses rendered the correction of the quadrantal errors practically unattainable. In 1876 Sir William Thomson invented a compass with much smaller needles than those previously used, which allows Sir George Airy's principles to be applied completely. With this compass correctors can be arranged so that the needle shall point accurately in all directions, and these correctors can be adjusted at sea from time to time, so as to eliminate any error which may arise through change in the ship's magnetism, or in the magnetism induced by the earth through change of the ship's position. By giving the compass-card a long period of free oscillation, great steadiness is obtained when the ship is rolling.

Sir William Thomson has also enriched the art of navigation by the invention of two sounding-machines; the one being devised for ascertaining great depths very accurately in less than one quarter the time formerly necessary, and the other for taking depths up to 130 fathoms without stopping the ship in its onward course. In both these instruments steel piano-forte wire is used instead of the hempen and silken lines formerly employed; in the latter machine the record of depth is obtained not by the quantity of wire run over its counter and brake-wheel, but through the indications produced upon a simple pressure-gauge consisting of an inverted glass tube, whose internal surface is covered beforehand with a preparation of chromate of silver, rendered colorless by the sea-water up to the height to which it penetrates. The value of this instrument for guiding the navigator within what he calls "soundings" can hardly be exaggerated; with the sounding-machine and a good chart he can generally make out his position correctly by a succession of three or four casts in a given direction at given intervals, and thus in foggy weather is made independent of astronomical observations, and of the sight of light-houses or the shore. By the proper use of this apparatus, such accidents as happened to the mail-steamer Mosel not a fortnight ago would not be possible. As regards the value of the deep-sea instrument I can speak from personal experience, as on one occasion it enabled those in charge of the cable steamship Faraday to find the end of an Atlantic cable, which had parted in a gale of wind, with no other indication of the locality than a single sounding, giving a depth of 950 fathoms. To recover the cable a number of soundings in the supposed neighborhead of the broken end were taken, the 950 fathom contour line was then traced upon a chart, and the vessel thereupon trailed its grapnel two miles to the eastward of this line, when it soon engaged the cable twenty miles away from the point, where dead reckoning had placed the ruptured end.

Whether or not it will ever be practicable to determine oceanic depths without a sounding-line, by means of an instrument based upon gravimetric differences, remains to be seen. Hitherto the indications obtained by such an instrument have been encouraging, but its delicacy has been such as to unfit it for ordinary use on board a ship when rolling.

The time allowed me for addressing you on this occasion is wholly insufficient to do justice to the great engineering works of the present day, and I must therefore limit myself to making a short allusion to a few only of the more remarkable enterprises.

The great success, both technically and commercially, of the Suez Canal, has stimulated M. de Lesseps to undertake a similar work of even more gigantic proportions, namely, the piercing of the Isthmus of Panama by a ship-canal, forty miles long, fifty yards wide on the surface, and twenty yards at the bottom, upon a dead level from sea to sea. The estimated cost of this work is £20,000,000, and, more than this sum having been subscribed, it appears unlikely that political or climatic difficulties will stop M. de Lesseps in its speedy accomplishment. Through it, China, Japan, and the whole of the Pacific Ocean will be brought to half their present distance, as measured by the length of voyage, and an impulse to navigation and to progress will thus be given which it will be difficult to overestimate.

Side by side with this gigantic work, Captain Eads, the successful improver of the Mississippi navigation, intends to erect his ship railway, to take the largest vessels, fully laden and equipped, from sea to sea, over a gigantic railway across the Isthmus of Tehuantepec, a distance of ninety-five miles. Mr. Barnaby, the chief constructor of the navy, and Mr. John Fowler have expressed a favorable opinion regarding this enterprise, and it is to be hoped that both the canal and the ship-railway will be accomplished, as it may be safely anticipated that the traffic will be amply sufficient to support both these undertakings.

Whether or not M. de Lesseps will be successful also in carrying into effect the third great enterprise with which his name has been prominently connected, the flooding of the Tunis-Algerian Chotts, thereby re-establishing the Lake Tritonis of the ancients, with its verdure-clad shores, is a question which could only be decided upon the evidence of accurate surveys, but the beneficial influence of a large sheet of water within the African desert could hardly be matter of doubt.

It is with a feeling not unmixed with regret that I have to record the completion of a new Eddystone Light-house in substitution for the *chef-d'œuvre* of engineering erected by John Smeaton more than one hundred years ago. The condemnation of that structure was not, however, the consequence of any fault of construction, but was caused by inroads of the sea upon the rock supporting it. The new light-house, designed and executed by Mr. (now Sir James) Douglass, engineer of Trinity House, has been erected in the incredibly short time of less than two years, and bids fair to be worthy of its famed predecessor. Its height above high water is one hundred and thirty feet, as compared with seventy-two feet, the height of Telford's structure, which gives its powerful light a considerably increased range. The system originally suggested by Sir William Thomson some years ago, of distinguishing one light from another by flashes following at varied intervals, has been adopted by the Elder Brethren in this as in other recent lights in the modified form introduced by Dr. John Hopkinson, in which the principle is applied to revolving lights, so as to obtain a greater amount of light in the flash.

The geological difficulties which for some time threatened the accomplishment of the St. Gothard Tunnel have been happily overcome, and this second and most important sub-Alpine thoroughfare now connects the Italian railway system with that of Switzerland and the south of Germany, whereby Genoa will be constituted the shipping port for those parts.

Whether we shall be able to connect the English with the French railway system by means of a tunnel below the English Channel is a question that appears dependent at this moment rather upon military and political than technical and financial considerations. The occurrence of a stratum of impervious gray chalk, at a convenient depth below the bed of the Channel, minimizes the engineering difficulties in the way, and must influence the financial question involved. The protest lately raised against its accomplishment can hardly be looked upon as a public verdict, but seems to be the result of a natural desire to pause pending the institution of careful inquiries. These inquiries have been made by a Royal Scientific Commission, and will be referred for further consideration to a mixed Parliamentary Committee, upon whose report it must depend whether the natural spirit of commercial enterprise has to yield in this instance to political and military considerations. Whether the Channel Tunnel is constructed or not, the plan proposed some years ago by Mr. John Fowler, of connecting England and France by means of a ferry-boat capable of taking railway trains, would be a desideratum justified by the ever-increasing intercommunication between this and Continental countries.

The public inconvenience arising through the obstruction to traffic by a sheet of water is well illustrated by the circumstance that both the estuaries of the Severn and of the Mersey are being undermined in order to connect the railway systems on the two sides, and that the Frith of Forth is about to be spanned by a bridge exceeding in grandeur anything as yet attempted by the engineer. The roadway of this bridge will stand one hundred and fifty feet above high-water mark, and its two principal spans will measure a third of a statute mile each. Messrs. Fowler and Baker, the engineers to whom this great work has been intrusted, could hardly have accomplished their task without having recourse to steel for their material of construction, nor need the steel used be of the extra-mild quality particularly applicable for naval structures to withstand collision, for, when such extreme toughness is not required, steel of very homogeneous quality can be produced, bearing a tensile strain double that of iron.

The tensile strength of steel, as is well known, is the result of an admixture of carbon with the iron, varying between one tenth and two per cent, and the nature of this combination of carbon with iron is a matter of great interest both from a theoretical and practical point of view. It could not be a chemical compound which would necessitate a definite proportion, nor could a mere dissolution of the one in the other exercise such remarkable influence upon the strength and hardness of the resulting metal. A recent investigation by Mr. Abel has thrown considerable light upon this question. A definite carbide of iron is formed, it appears, soluble at high temperatures in iron, but separating upon cooling the steel gradually, and influencing only to a moderate degree the physical properties of the metal as a whole. In cooling rapidly there is no time for the carbide to separate from the iron, and the metal is thus rendered both hard and brittle. Cooling the metal gradually, under the influence of great compressive force, appears to have a similar effect to rapid cooling in preventing the separation of the carbide from the metal, with this difference, that the effect is more equal throughout the mass, and that more uniform temper is likely to result.

When the British Association met at Southampton on a former occasion, Schönbein announced to the world his discovery of gun-cotton. This discovery has led the way to many valuable researches on explosives generally, in which Mr. Abel has taken a leading part. Recent investigations by him, in connection with Captain Noble, upon the explosive action of gun-cotton and gunpowder confined in a strong chamber, which have not yet been published, deserve particular attention. They show that while by the method of investigation pursued about twenty years ago by Karolye (of exploding gunpowder in very small charges in shells confined within a large shell partially exhausted of air) the composition of the gaseous products was found to be complicated and liable to variation, the chemical metamorphosis which gun-cotton sustains, when exploded under conditions such as obtain in its practical application, is simple and very uniform. Among other interesting points noticed in this direction was the fact that, as in the case of gunpowder, the proportion of carbonic acid increases, while that of carbonic oxide diminshes with the density of the charge. The explosion of gun-cotton, whether in the form of wool or loosely spun thread, or in the packed compressed form devised by Abel, furnished practically the same results if fired under pressure, that is, under strong confinement—the conditions being favorable to the full development of its explosive force; but some marked differences in the composition of the products of metamorphosis were observed when gun-cotton was fired by detonation. With regard to the tension exerted by the products of explosion, some interesting points were observed, which introduce very considerable difficulties into the investigation of the action of fired gun-cotton. Thus, whereas no marked differences are observed in the tension developed by small charges and by very much larger charges of gunpowder having the same density (i. e., occupying the same volume relatively to the entire space in which they are exploded), the reverse is the case with respect to gun-cotton. Under similar conditions in regard to density of charge, 100 grammes of gun-cotton gave a measured tension of about 20 tons on the square inch, 1,500 grammes gave a tension of about 29 tons (in several very concordant observations), while a charge of 2·5 kilos gave a pressure of about 45 tons, this being the maximum measured tension obtained with a charge of gunpowder of five times the density of the above.

The extreme violence of the explosion of gun-cotton as compared with gunpowder when fired in a closed space was a feature attended with formidable difficulties. In whatever way the charge was arranged in the firing-cylinder, if it had free access to the inclosed crusher-gauge, the pressures recorded by the latter were always much greater than when means were taken to prevent the wave of matter suddenly set in motion from acting directly upon the gauge. The abnormal or wave-pressures recorded at the same time that the general tension in the cylinder was measured amounted in the experiment to 42·3 tons, when the general tension was recorded at 20 tons; and in another, when the pressure was measured at 29 tons, the wave-pressure recorded was 44 tons. Measurements of the temperature of explosion of gun-cotton showed it to be about double that of the explosion of gunpowder. One of the effects observed to be produced by this sudden enormous development of heat was the covering of the inner surfaces of the steel explosion-vessel with a net-work of cracks, small portions of the surface being sometimes actually fractured. The explosion of charges of gun-cotton up to 2·5 kilos in perfectly closed chambers, with development of pressures approaching to 50 tons on the square inch, constitutes alone a perfectly novel feat in investigations of this class.

Messrs. Noble and Abel are also continuing their researches upon fired gunpowder, being at present occupied with an inquiry into the influence exerted upon the chemical metamorphosis and ballistic effects of fired gunpowder by variation in its composition, their attention being directed especially to the discovery of the cause of the more or less considerable erosion of the interior surface of guns produced by the exploding charge—an effect which, notwithstanding the application of devices in the building up of the charge specially directed to the preservation of the gun's bore, has become so serious that, with the enormous charges now used in our heavy guns, the erosive action on the surface of the bore produced by a single round is distinctly perceptible. As there appeared to be *prima facie* reasons why the erosive action of powder upon the surface of the bore at the high temperatures developed should be at any rate in part due to its one component sulphur, Noble and Abel have made comparative experiments with powders of usual composition and with others in which the proportion of sulphur was considerably increased, the extent of erosive action of the products escaping from the explosion-vessel under high tension being carefully determined. With small charges a particular powder containing no sulphur was found to exert very little erosive action as compared with ordinary cannon-powder; but another powder, containing the maximum proportion of sulphur tried (15 per cent), was found equal to it under these conditions, and exerted very decidedly less erosive action than it, when larger charges were reached. Other important contributions to our knowledge of the action of fired gunpowder in guns, as well as decided improvements in the gunpowder manufactured for the very heavy ordnance of the present day, may be expected to result from a continuance of these investigations. Professor Carl Himly, of Kiel, having been engaged upon investigations of a similar nature, has lately proposed a gunpowder in which hydrocarbons precipitated from solution in naphtha take the place of the charcoal and sulphur of ordinary powder. This powder has among others the peculiar property of completely resisting the action of water, so that the old caution, "Keep your powder dry," may hereafter be unnecessary.

The extraordinary difference of condition, before and after its ignition, of such matter as constitutes an explosive agent leads us up to a consideration of the aggregate state of matter under other circumstances. As early as 1776, Alexander Volta observed that the volume of glass was changed under the influence of electrification, by what he termed electrical pressure. Dr. Kerr, Govi, and others have followed up the same inquiry, which is at present continued chiefly by Dr. George Quincke, of Heidelberg, who finds that temperature, as well as chemical constitution of the dielectric under examination, exercises a determining influence upon the amount and character of the change of volume effected by electrification; that the change of volume may under certain circumstances be effected instantaneously as in flint-glass, or only slowly as in crown-glass, and that the elastic limit of both is diminished by electrification, whereas in the case of mica and of gutta-percha an increase of elasticity takes place.

Still greater strides are being made at the present time toward a clearer perception of the condition of matter when particles are left some liberty to obey individually the forces brought to bear upon them. By the discharge of high-tension electricity through tubes containing highly rarefied gases (Geissler's tubes), phenomena of discharge were produced which were at once most striking and suggestive. The Sprengel pump afforded a means of pushing the exhaustion to limits which had formerly been scarcely reached by the imagination. At each step the condition of attenuated matter revealed varying properties when acted upon by electrical discharge and magnetic force.

The radiometer of Crookes imported a new feature into these inquiries, which at the present time occupy the attention of leading physicists in all countries.

The means usually employed to produce electrical discharge in vacuum-tubes was Ruhmkorff's coil; but Mr. Gassiot first succeeded in obtaining the phenomena by means of a galvanic battery of 3,000 Leclanché cells. Dr. De La Rue, in conjunction with his friend Dr. Hugo Müller, has gone far beyond his predecessors in the production of batteries of high potential. At his lecture "On the Phenomena of Electric Discharge," delivered at the Royal Institution, in January, 1881, he employed a battery of his invention consisting of 14,400 cells (14,832 Volts), which gave a current of 0·054 Ampère, and produced a discharge at a distance of 0·71 inch between the terminals. During last year, he increased the number of cells to 15,000 (15,450 Volts), and increased the current to 0·4 Ampère, or eight times that of the battery he used at the Royal Institution.

With the enormous potential and perfectly steady current at his disposal, Mr. De La Rue has been able to contribute many interesting facts to the science of electricity. He has shown, for example, that the beautiful phenomena of the stratified discharge in exhausted tubes are but a modification and a magnification of those of the electric arc at ordinary atmospheric pressure. Photography was used in his experiments to record the appearance of the discharge, so as to give a degree of precision otherwise unattainable in the comparison of the phenomena. He has shown that between two points the length of the spark, provided the insulation of the battery is efficacious, is as the square of the number of cells employed. Mr. De La Rue's experiments have proved that at all pressures the discharge in gases is not a current in the ordinary acceptation of the term, but is of the nature of a disruptive discharge. Even in an apparently perfectly steady discharge in a vacuum-tube, when the strata as seen in a rapidly revolving mirror are immovable, he has shown that the discharge is a pulsating one; but, of course, the period must be of a very high order.

At the Royal Institution, on the occasion of his lecture, Mr. De La Rue produced, in a very large vacuum-tube, an imitation of the aurora borealis; and he has deduced from his experiments that the greatest brilliancy of aurora displays must be at an altitude of from thirty-seven to thirty-eight miles—a conclusion of the highest interest, and in opposition to the extravagant estimate of 281 miles at which it had been previously put.

The President of the Royal Society has made the phenomena of electrical discharge his study for several years, and resorted in his important experiments to a special source of electric power. In a note addressed to me, Dr. Spottiswoode describes the nature of his investigations much more clearly than I could venture to give them. He says: "It had long been my opinion that the dissymmetry shown in electrical discharges through rarefied gases must be an essential element of every disruptive discharge, and that the phenomena of stratification might be regarded as magnified images of features always present, but concealed under ordinary circumstances. It was with a view to the study of this question that the researches by Moulton and myself were undertaken. The method chiefly used consisted in introducing into the circuit intermittence of a particular kind, whereby one luminous discharge was rendered sensitive to the approach of a conductor outside the tube. The application of this method enabled us to produce artificially a variety of phenomena, including that of stratification. We were thus led to a series of conclusions relating to the mechanism of the discharge, among which the following may be mentioned:

"1. That a stria, with its attendant dark space, forms a physical unit of a striated discharge; that a striated column is an aggregate of such units formed by means of a step-by-step process; and that the negative glow is merely a localized stria, modified by local circumstances.

"2. That the origin of the luminous column is to be sought for at its negative end; that the luminosity is an expression of a demand for negative electricity; and that the dark spaces are those regions where the negative terminal, whether metallic or gaseous, is capable of exerting sufficient influence to prevent such demand.

"3. That the time occupied by electricity of either name in traversing a tube is greater than that occupied in traversing an equal length of wire, but less than that occupied by molecular streams (Crookes's radiations) in traversing the tubes. Also that, especially in high vacua, the discharge from the negative terminal exhibits a durational character not found at the positive.

"4. That the brilliancy of the light with so little heat may be due in part to brevity in the duration of the discharge; and that, for action so rapid as that of individual discharges, the mobility of the medium may count as nothing; and that for these infinitesimal periods of time gas may itself be as rigid and as brittle as glass.

"5. That striæ are not merely loci in which electrical is converted into luminous energy, but are actual aggregations of matter.

"This last conclusion was based mainly upon experiments made with an induction-coil excited in a new way—viz., directly by an alternating machine, without the intervention of a commutator or condenser. This mode of excitement promises to be one of great importance in spectroscopic work, as well as in the study of the discharge in a magnetic field, partly on account of the simplification which it permits in the construction of induction-coils, but mainly on account of the very great increase of strength in the secondary currents to which it gives rise."

These investigations assume additional importance when we view them in connection with solar—I may even say stellar—physics, for evidence is augmenting in favor of the view that interstellar space is not empty, but is filled with highly attenuated matter of a nature such as may be put into our vacuum-tubes. Nor can the matter occupying stellar space be said any longer to be beyond our reach for chemical and physical test. The spectroscope has already thrown a flood of light upon the chemical constitution and physical condition of the sun, the stars, the comets, and the far-distant nebulæ, which have yielded spectroscopic photographs under the skillful management of Dr. Huggins, and Dr. Draper, of New York. Armed with greatly improved apparatus, the physical astronomer has been able to reap a rich harvest of scientific information during the short periods of the last two solar eclipses; that of 1879, visible in America, and that of May last, observed in Egypt by Lockyer, Schuster, and by Continental observers of high standing. The result of this last eclipse expedition has been summed up as follows: "Different temperature levels have been discovered in the solar atmosphere; the constitution of the corona has now the possibility of being determined, and it is proved to shine with its own light. A suspicion has been aroused once more as to the existence of a lunar atmosphere, and the position of an important line has been discovered. Hydrocarbons do not exist close to the sun, but may in space between us and it."

To me personally these reported results possess peculiar interest, for in March last I ventured to bring before the Royal Society a speculation regarding the conservation of solar energy, which was based upon the three following postulates, viz.:

1. That aqueous vapor and carbon compounds are present in stellar or interplanetary space.

2. That these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation.

3. That the effect of solar rotation is to draw in dissociated vapors upon the polar surfaces, and to eject them, after combustion has taken place, back into space equatorially.

It is therefore a matter of peculiar gratification to me that the results of observation here recorded give considerable support to that speculation. The luminous equatorial extensions of the sun which the American observations revealed in such a striking manner (with which I was not acquainted when writing my paper) were absent in Egypt; but the outflowing equatorial streams I suppose to exist could only be rendered visible by reflected sunlight, when mixed with dust produced by exceptional solar disturbances or by electric discharge; and the occasional appearance of such luminous extensions would serve only to disprove the hypothesis entertained by some, that they are divided planetary matter, in which case their appearance should be permanent. Professor Langley, of Pittsburg, has shown, by means of his bolometer, that the solar actinic rays are absorbed chiefly in the solar instead of in the terrestrial atmosphere, and Captain Abney has found by his new photometric method that absorption due to hydrocarbons takes place somewhere between the solar and terrestrial atmosphere; in order to test this interesting result still further, he has lately taken his apparatus to the top of the Riffel with a view of diminishing the amount of terrestrial atmospheric air between it and the sun, and intends to bring a paper on this subject before Section A. Stellar space filled with such matter as hydrocarbon and aqueous vapor would establish a material continuity between the sun and his planets, and between the innumerable solar systems of which the universe is composed. If chemical action and reaction can further be admitted, we may be able to trace certain conditions of thermal dependence and maintenance, in which we may recognize principles of high perfection, applicable also to comparatively humble purposes of human life.

We shall thus find that, in the great workshop of Nature, there are no lines of demarkation to be drawn between the most exalted speculation and commonplace practice, and that all knowledge must lead up to one great result, that of an intelligent recognition of the Creator through his works. So, then, we members of the British Association and fellow-workers in every branch of science may exhort one another in the words of the American bard who has so lately departed from among us:

"Let us then be up and doing,
With a heart for any fate;
Still achieving, still pursuing,
Learn to labor and to wait."

MUSICAL SENSATIONS.

By M. HÉRICOURT.

IT is common, in defining music, to compare it with some other art, painting, for instance, and say it is to the ear what that is to the eye; that it is the representation of the ideal by a means especially adapted to the organ to which it is addressed, or by the combination of sounds. Is that all that it is? Do we not forget, when we simply put it on a par with other arts, the exceptional part it plays in the life of men? The universal adaptation of music to all degrees of civilization, the peculiar charm of which it is the source, and the extraordinary power it exercises, are so many reasons for believing that it is connected with our organization by a more intimate tie than that which binds other arts to it, and that it is the manifestation of a more general faculty. When Fetis wrote, in 1837, the idea prevailed that music originated in the imitation of the songs of birds. He contradicted this, and defined music as the double result of the conformation of the organs and the disposition of the soul, as the art of awakening emotion by means of the combination of sounds. It is, in fact, generally agreed that music addresses itself more directly to our feelings and passions, and is correctly said that it speaks to them in a special language. Descartes indicated this as its object.

In the theory of Helmholtz, music expresses the different dispositions of the soul by imitating the characteristic particularities of movement in space, and by thus translating the forces and impulses that produce the movement. While he admits that it may have been at first only an imitation of the instinctive modulations of the voice corresponding with the different states of the mind, he does not consider this fact contradictory to his definition, for the natural processes of vocal expression are capable of being traced back to the same elements. "Rhythm and accentuation express directly the rapidity and vivacity of corresponding psychical movements; a vehement effort causes the voice to rise; the desire to produce an agreeable impression on another person prompts us to select a pleasant tone; and thus the efforts to imitate the involuntary modulations of the voice, to enrich and make more expressive the recitation of words, may very probably have guided our ancestors in seeking out the means for musical expression."

This is probably the real origin of music; and it is in this direction that we should look in investigating its nature.

Two elements closely connected, but quite different and having each its peculiar function, may be distinguished in the analysis of spoken language—the intonation and the articulation of the emitted sound. No doubt they are the interpreters of the two great human faculties of intelligence and feeling. Speech, then, is a complex physiological resultant, the double image of a double inner condition. The elements it represents can not be conceived as isolated from each other, any more than we can conceive a human organization a pure intelligence. We all know the important part intonation plays in conversation, and how by it the general sense, the whole expression of the spoken words, may be varied indefinitely.

Having thus found the origin of music in the imitation of these instinctive modulations of speech, it should be easy to draw from this an exact idea of its nature; for, without doubt, to read verse well, to declaim with warmth and conviction, is only to perform in advance the work of the musician. We have now a whole class of musical phrases which are only exaggerations of spoken intonations; they are our recitatives. The music of uncultivated peoples is mostly recitative; so also was a large part of the music of the middle ages. The rules and grammar of music and its particular features are the growth of modern times.

This conception of music as the language of sensibility permits us to explain the characteristic features of its action. We must consider, first, that this language, like its twin sister the language of ideas, has suffered a progressive evolution, and has with us reached a great perfection, and consequently a great complexity in its laws and processes. Among primitive peoples of few ideas, whose feelings show few variations of shade in expression, music is almost wholly confined to a few modulations expressive of the principal divisions of feeling—love, joy, sorrow, and warlike ardor. Civilization, with its refinements, has produced a music that has grown constantly richer in shades and means of expression, to the point which has been reached by the great masters of our age.

Neither language is intelligible to all, in its fullest degree of development. As we must have the power of comprehending abstract ideas in order to understand philosophers, so we must be more or less accustomed to musical sensations to appreciate the great musicians; and it is interesting to observe how we learn by study to enjoy works which at first fall cold upon us.

The application of such a word as comprehend, or understand, to music, is a source of numerous misconceptions; music does not understand, it feels. It addresses itself only to that part of us which is susceptible of emotion; and we frequently lose all its charm by our trying to understand it, or to find in it ideas which it can not express. We might expect the same kind of a failure if we should try to find sources of emotion in the working out of an equation.

It is true that persons exist who have no sense for music, and to whom its language is a blank; but they are rarely found, and prove nothing. Opposed to them are much more frequent instances of excessively sensitive natures, on whom even simple single musical intervals produce wonderful effects. Who has not made music without suspecting it? In certain states of feeling we are sometimes surprised to find ourselves composing simple melodies that are never finished, and are major or minor according as we are gay or sad, while we may be totally ignorant of the existence of those modes. Some natures seem obliged thus to express themselves in song. This is because speech is really an imperfect means of expressing the feelings. It is just as necessary to address the feelings, to make an emotion known, as it is to address the intellect, to communicate an idea. Hence the charm of the opera, in which the words describe the situation, while the music enables us to see into the hearts of the persons who are implicated in it. A certain school of operatic composers, indeed, are not concerned about depicting the passions set forth in their dramas, but are satisfied if they can introduce a few agreeable melodies good to sing anywhere and to any words, and which will become favorites; but this is not the case with real dramatic music as illustrated in the works of Gluck, Berlioz, Meyerbeer, Rossini, Verdi in his second style, and Wagner.

In songs, the expression is in an inverse ratio to the interest of the words. Good poetry is hardly susceptible of any but an uncolored music, just enough to sustain the voice; the thought, in effect, crowds out the feeling, and, a choice being forced upon the attention, too much musical accent would weaken the thought. For a full musical interpretation of the feeling, a third-rate poetry, only indicating the subject, is best, for it permits the concentration of all the attention upon the emotional expression. This is, ordinarily, the character of the librettos of operas, in which everything is subordinated to the music; but the song, the interest of which lies in the conception, is accommodated with a colorless melody.

By considering music as the language of the feelings, we are enabled to account for the power it has over masses composed of the most incongruous elements. An address can not affect alike persons of different degrees of intellectual development, and must fall without making any impression on a part of the audience. There is less difference in the capacity for feeling, and all are more or less subject to the same transports of emotion. The masses feel more than they think.

It is interesting to remark the generally simple and touching expression of popular songs. The feeling is brought out in its purity without science or preparation, and the result is a music full of artless charms, the inexhaustible source to which composers, knowing that they can not find better ones, go for the themes of their works. These popular songs are generally of a sad character, and tell of vague aspirations and indefinite desires. Thus have originated those dreamy melodies with which working-people love to lull their melancholy, and which are frequently the only source to which we can go for the history of those who have lived and suffered in obscurity.

As different human races have their several languages, so each one has its own musical system; and these various systems, the existence of which is explainable by the action of the same causes that have made different words to designate the same things, prove that the origin of the two languages is common, and that the one is the spontaneous expression of feelings, as the other is of thoughts. Like alphabets, gamuts also may differ within certain limits. They are also not fixed, and undergo the evolution common to all languages. Most uncivilized peoples are unacquainted with semitones, and use scales with full intervals. This is easily accounted for if we suppose that these intervals are the ones which represent the elementary intonations, and that they constitute a music near its origin. The need of representing shades of feeling brings about a progressive filling up of the intervals. The ancient Celts excluded semitones, while the music of the Greeks found refined expression in quarter-tones. Our musicians are also sometimes tempted to reduce our minimum interval of a semitone, and some performers abuse this process to an extravagant degree.

The effect produced upon our ear by music of a system different from ours is generally painful; but we have no right to say that the Indians and the Arabs sing false. We have to learn a language to understand it; and a quite short accustoming is generally sufficient for a music that appeared savage and harsh, at the first hearing, to become supportable, if not agreeable.

Music nearly always commands the attention of animals; and every one knows what curious results have been obtained from experiments on different species, from the elephant to the spider. This language of feeling is really more within their reach than speech; and we may generally remark that when we address ourselves to our domestic animals it is by the intonation alone, of greater or less force, that we make them understand—that is, feel. Articulate words have no meaning for them, except on condition of a previous education based on the assciation of sensations. A dog is never mistaken as to the intention of a person calling him, and the tone alone tells him whether a caress or correction is in waiting for him. So music is never heard by animals with indifference.

After what has been said it would be idle to consider the rank which music holds among the other arts; its origin, its nature, and its effects give it a separate place. It is a language which everybody understands, which nearly all speak to some extent, and in which some rise to a sublime eloquence.

Poetry, with its measure and rhythm, is the first intermediary between speech and music; but it lacks vastly the power of the latter, because of the degree of intellectual culture it exacts. Mimicry comes nearer to music in its effects, for it leaves the idea vague, and speaks more directly to the feelings; and it is a great aid to the orator. But the most powerful orator is he who has a musical intonation.

An interesting investigation might be made of the various musical accents which answer to different conditions of feeling. To ascertain this correctly would require a long and minute course of experiments. It is curious to observe, however, that Gluck, Mozart, Berlioz, Meyerbeer, and Wagner, when they have the same situations to depict, whether in recitative or melody, use the same musical intonations. It thus appears that the major third is generally employed in interrogations and appeals, and that the appellative character of that interval becomes more marked and impressive in the fourth descending, while the fourth ascending denotes affirmation, decision, command. The minor and major fifths express the feelings from prayer to violent desire and menace. The sixth is the interval of passion; it is the symbol of a very accentuated emotion, and is inevitably met where love is declared. A semitone higher conveys the idea of something painful, which is resolved into a real expression of grief in the cry of the seventh, the symbol of an excess of suffering. There are, in effect, no two ways of saying the same thing in music, and it is only in the way the phrase is introduced and sustained by the harmony that authors vary. We are speaking, of course, only of those passages of the songs in which the emotions are exploded, for it is in these only that the author, not caring to expend his force over the whole phrase, aims to bring out his full meaning. From these comparisons of emotions and intonations we are able to discover the physiological reason of the correspondence between the note and expression. The smaller intervals are congenial with indifference, monotony, doubt, melancholy, and sadness; the group of moderate intervals affirms occupation, pleasure, and desire, which grow more ardent as we approach the extreme intervals; and in these we look for the most intense feeling. Melancholy sentiments involving diminished vitality, we might naturally conceive them to be expressed musically by diminished intervals, the compass of which requires little effort; while earnest desires, strong passions, and pleasant and happy feelings, being accompaniments of a more active vitality, provoke more vigorous expressions; and these expressions, by giving an outlet to the excess of vitality, furnish one of the best means for calming violent passions.

We add a few words on the nature of musical pleasure. It is dependent on variety—the essential condition of all pleasure, that of the mind as well as that of the senses; variety of ideas for the former, variety of sensations for the latter. Nothing, in fact, is more incompatible with pleasure than monotony, even in agreeable things. The feelings do not escape this general law; and the cause of musical enjoyment must be sought in the infinite variety of conditions of feeling through which the rapid succession of musical intervals makes us pass. In this, we do not speak of the merely material pleasure of the sense of hearing, which may exist aside from all attention; but of the stirring up of the whole being by the emotions. To this enjoyment, which exists parallel with the succession of sounds, should be added the pleasure of the hearer's adapting his personal feelings of the moment to the general sense of the performed music: a theme marked with melancholy will move a whole audience of thousands to sadness, each person of whom will associate his feeling with some particular object. This impersonality of the musical phrase and its adaptability to individual feelings explain the taste of the masses for music, and its power over them. The system of tones, by furnishing a kind of stable basis for the undulating variety of musical sounds, effects in music a union of the two chief conditions of pleasure—variety in unity.

It is impossible to treat of music without speaking of rhythm, which, without being an essential part of it, enframes it, sustains it, and gives precision to its otherwise vague expression. The origin of rhythm need be sought no further off than in the movements and paces of men. Descartes finds it in the efforts of the voice in sing-ing, or the gestures of the instrumentalist; every accent is preceded by an inspiration or a drawing of the bow, marking the beginning of a new effort. These efforts, methodically arranged, give musical measure.

Different rhythms reflect the different paces of the walker or the rider plainly enough to justify us in attributing their origin to them. The same cause that makes one pace his room with gaits varying according to the impressions of the moment, in the reverie of solitude or in conversation, also determines the rhythm in music.

Just as our emotional being loves to be amused by rhythms suggesting natural outer movements, so certain cadenced sounds casually heard, such as that of a passing train, the trotting of a horse, or the beating of oars, induce states of sensibility, under the influence of which we surprise ourselves by humming old airs, or by improvising melodies that naturally adapt themselves to the fortuitous movement.

This conception of the origin of music explains the universality of its domain and its power, as well as all the particular facts connected with its different adaptations.—*Translated from the Revue Scientifique.*

IS FINGAL'S CAVE ARTIFICIAL?*

By F. COPE WHITEHOUSE, M. A., ETC.

IN venturing to ask a question and thus imply a doubt upon a point on which geologists, statesmen, and poets have given their consentient opinion for a century, it is not without regret that an opinion, held without suspicion of challenge, should be subjected to criticism, and better proof than prescription required for the title by which this celebrated cavern has been held and enjoyed as the work of Nature.

The process of reasoning which led me to believe that the cavern owes its existence to the hand of man had little in common with the arguments by which the inference is now supported. In June, 1881, while examining the Giants' Causeway, it seemed evident that columnar basalt showed no tendency to erode and form hollows. Where the basalt, which for the height of some hundreds of feet above the chalk is quite amorphous, and caps the low promontories along the coast, is brought so low that more than one half of its thickness is immersed in the sea, the remainder projects above the water and forms the well-known natural pier. The caves on that coast are in the great

* A summary of an address made before the American Association for the Advancement of Science at Montreal, August 30th, and the Academy of Science at New York, October 9, 1882, illustrated by photographs and diagrams.

ochre-bed or chalk. They are plainly artificial in their present form. The peculiar Gothic door-way and the sheltered approach strengthen the view that they bear a distinct relation to an ancient civilization, and that it is not by accident that adjacent cliffs are crowned with castles, neighboring mines were worked from unknown periods, beacon-rocks bear mythological names, and manuscripts refer to maritime expeditions to the Baltic and Mediterranean. It seemed antecedently possible that the same race, Kelto-Iberian, Wend, or Phœnician, which had formed harbors on the coast of Ireland, might also have been the active agent in that perforation which has been termed the most remarkable in Europe. This conjecture received strong and unexpected confirmation. It was submitted to rigid examination; it was strengthened by opposition. It has been adopted, by a considerable number of eminent men, as a far stronger *prima facie* case than that commonly stated by the text-books in favor of marine erosion. If not well founded, it still suggests difficulties which have escaped observation, and may also correct the inaccurate terms in which Fingal's Cave has been described, and the imperfect representations which have gone far to perpetuate the hasty conclusion of Sir Joseph Banks.

Fingal's Cave is not at the Giants' Causeway. It is in the southern end of the Island of Staffa, whose apparent size and position are necessarily exaggerated on the maps in common use. It is not "off the

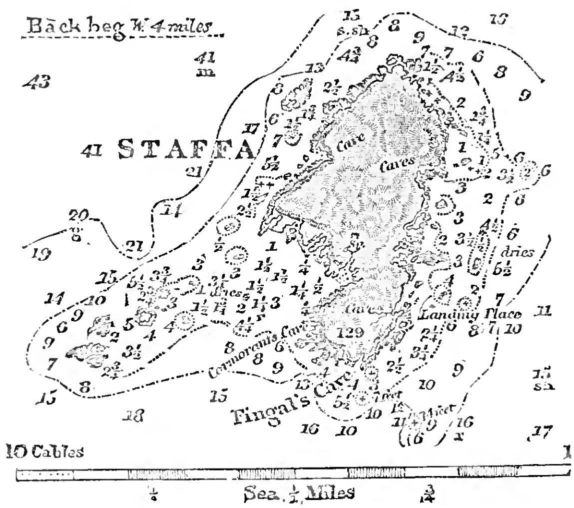

Fig. 1.—From the Admiralty Chart of Loch Tuadh.

southwest coast of Scotland." It is deeply embayed in a large sinuosity formed by the Island of Mull, and nearly inclosed on the opposite side by Iona and the Treshnish Islands. Beyond the latter a second line is drawn by Tiree and Coll, while to the north but to a greater distance are placed the islands of Minch, Rum, Eigg, and Canna. The circle is completely closed for 315° by land, distant at farthest from five to seven miles. From Dutchman's Cap, bearing nearly due west, to the "Stac" off Iona, there is comparatively deep water of forty to fifty fathoms. The charts, however, show that rocks approach the surface. "Five-Fathom Rock," "Dangerous Overfalls," and soundings of less than ten fathoms, push half-way across the Passage of Tiree. Mackenzie's Rock, which dries in four feet, guards the other entrance, and no Atlantic surge could pass into Loch Tuadh or the Sound of Iona, without changing its direction twice and almost at right angles. But Donegal receives the impetus of the tremendous billows which break against the steep cliffs of Mizen Head, or rush up the narrow gorges with which the exposed coast of the Northern Hebrides is so deeply scored. Staffa is singularly sheltered. It makes it antecedently extremely improbable that this particular spot would be selected by the ocean as a place on which to "prove its strength." Wordsworth was both a landsman and a poet, and, as he says—

> "In a motley crowd, each the other's blight,
> Hurried and hurrying"—

only *saw* it. His language, however, has undoubtedly been made a vehicle of scientific error.

"Caves worn by the sea are due to the set of the currents, the force of the breakers, and the grinding of the shingle, which inevitably discover the weak places in the cliff, and leave caves as one of the results of their work, modified in each case by the local conditions of the rock" ("Encyclopædia Britannica"). Assuming that this is a complete statement of the law of marine erosion, how was Fingal's Cave "hollowed out of columnar basalt," and therefore rightly classed by Professor Boyd Dawkins, "among caves worn by the sea"? There is no current setting into this bay. The spring tides rise $11\frac{3}{4}$ feet, neaps 8 feet, and range $4\frac{1}{2}$ feet. The maelstrom of that part of the ocean is "where Corryvrechan's surges driven" make "the caldron of the spectral sea," but to the south, behind Colonsay. The force of the breakers is inconsiderable. Either they are the result of local disturbance formed to the east of Tiree, or the ground-swell and heaving of the sea after a storm. The island is fully protected by its own foreshore. The perpendicular columns suggest an "unknown profundity of depth." But the basalt on the west is over 50 feet above the sea-level. A spit of conglomerated trap or tufa prolongs under water a flat, rocky shore. There is a succession of rocks and shoals. The 20-fathom line is a mile distant, the 10-fathom half a mile, immediately followed by rocks, and 12, 15, and 9 feet of water. As the cave is in the southern face, it appears to be impossible, in the present state of the coast, that a wave with any momentum could strike directly upon that end of the island. As MacCulloch sat on one of the columns, though the long swell raised the water at intervals to his feet, the movement was silent, and the surface of the sea apparently undisturbed. There is

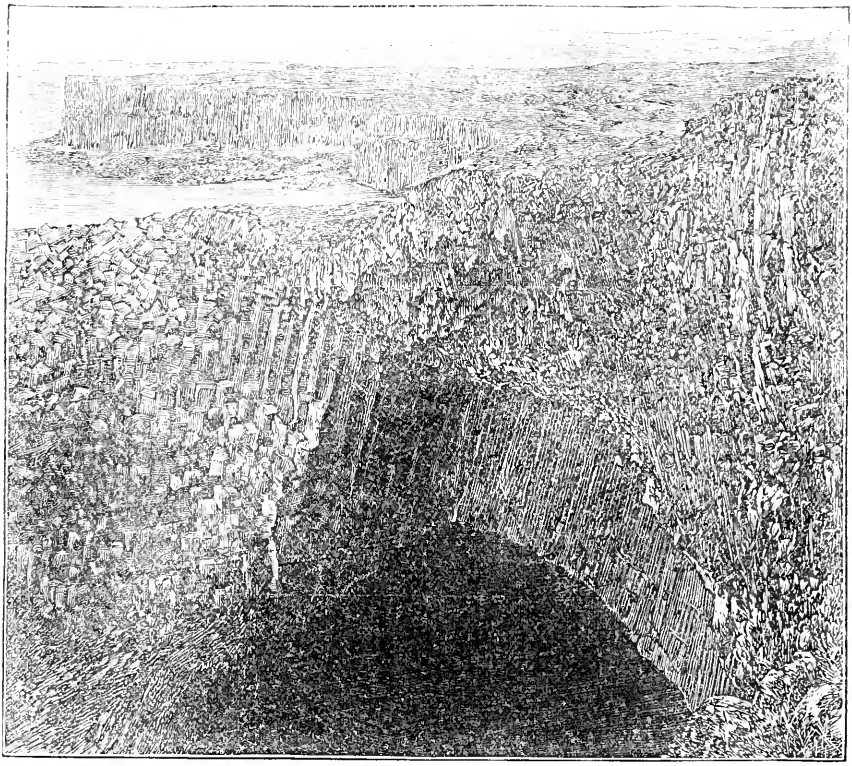

Fig. 2.—West Side of Staffa, 1463. G. W. W. Showing Arched Entrance to Cormorant's Cave.

no shingle. The prismatic blocks are refractory. If a wave struck with sufficient force to dislodge the drums, or if, undermining the tuff, it strewed the beach with hexagonal or pentagonal blocks, these smooth stones, with polished sides, buried in the finer material, would offer very great resistance to any further waste of the cliff. Although a channel of 18 feet at mean low water approaches and enters the cave, there is no ledge over which the material could have been carried. The sharp conchoidal fracture would not serve the purpose of such crystalline rocks as quartz or granite, and furnish the fluid wave with a serrated edge.

The cave is not formed in what would naturally be considered *the* cliff; least of all in its weakest place. After examining the Admiralty Chart, "the reader will, no doubt, pass with pleasure to the rich description by Dr. MacCulloch." That author, however, says that the whole of Fingal's Cave seemed like a ship heaving in a sea-way, and therefore his survey may be considered less trustworthy than that of Commanders Bedford and Creyke (Admiralty Chart, 1857). It seems incorrect to say, "The caves are so numerous that they may be said to perforate at brief intervals the whole face of the island; but those which occur on the south (*sic*, query west) and the north sides are remarkable neither for beauty nor for magnitude." The caves are sufficiently numerous to furnish an argument. There are very few hollows worn by the sea in the Scotch coast. The islet, which contains a dozen, has not the $\frac{1}{1000000}$ part of the indented line of the mainland, and bears an infinitesimal ratio to the sea-board, including the islands. Its parent, Mull, within whose bosom rests this irregularly oval rock, "measuring about one and a half mile in circumference," has in the dimension of length one hundred and fifty times better right to a "museum of wonders." The "Isle of Columns" is a speck too tiny to show on any ordinary map. The chance that it would contain, as a legitimate yet exceptional result of normal contact between igneous rock and sea-water agitated by wind, "the most remarkable cave in Europe," is less than 0. It is the $\sqrt{-1}$.

The uneven table-land is formed of "three distinct beds of rock of unequal thickness, inclined toward the east at an angle of about nine degrees. The lowest is a rude trap tufa, the middle one is divided into columns placed vertically to the plane of the bed, and the uppermost is an irregular mixture of small columns and shapeless rock." The columnar bed is never more than 60 feet thick. The island itself attains a maximum height of 129 feet. It has no peak from which rain-water might descend in a considerable quantity. There is no series of fissures corresponding to the perforations. There is nothing on the flat top to suggest the tunnels beneath. Proceeding toward the south from the landing-place, there are six cases of alleged erosion, each presenting its own seemingly insuperable difficulty, and cumulatively requiring a more thoughtful and serious consideration than the fantastic phrases in which 'stupendous (!) columns, three feet thick and thirty feet high, rise from a *dark-red* or violet-colored rock over which *the ocean* rolls, and reflects from its *white* bottom a variety of *crimson* and *yellow*.'

It appears now to be well established that the peculiar structure of columnar basalt is due to contraction and splitting consequent upon cooling. The analogy is rather to the splitting often seen in the mud bottom of a dried-up pool than to ordinary crystallization. The various conditions point to the contractile origin of the structure, at the same time that the result suggests a curious mimicry of imperfect crystallization. If the cooling mass of basalt be in one of its vertical sections of such a form that successive isothermal *couches*, taken in descending order, are not parallel to the original cooling surface, as they are in all cases of straight and parallel prisms, but divergent gradually from the cooling surface and from each other, then the lines of the splitting of the prisms, always true to these *couches*, must be curved in one direction. This will be true, whether the isothermal *couches* be plane surfaces divergent from a thinner to a thicker part of the mass, or whether they be curved surfaces arising from the mass reposing on a curved bottom and diverging in like manner. The *crux* of Staffa is Scallop or Clamshell Cave. Inattention has caused the various authors to describe it as if there was nothing astonishing in the sudden interruption of the columns, which are "bent so as to form on one side a

Fig. 3.—Fingal's Cave, Staffa, 1111. J. V.

series of ribs not unlike an inside view of the timbers of a ship," while "the opposite wall is formed by the ends of columns, and bears a general resemblance to the surface of a honey-comb." Sixteen feet wide, 130 feet long, how could the sea attack the landward, southeast end, and carve a trench 45 to 50 feet deep, where it is geologically impossible that a "fault" or "weak place" aided the natural force? The channel of Bouchaillie, seen from the cliff above, is a canal cut through the columnar basalt, and taking a slice from that conoidal pile of columns about thirty feet high, which is seen a few yards to the right of the Colonnade and Fingal's Cave. Where is the *débris?* Why should it be crossed at right angles by the passage leading into the Clamshell Cave? The Causeway here presents an extensive surface, which terminates in a long, projecting point at the eastern side of the Great Cave. It is formed normally. The heads of columns show in a compact and serried phalanx. Each row protects the other in turn. The tesselated pavement, as on the Irish coast, is a firm, impenetrable mass, showing by its steepness its utter contempt for the wavelets which could not break those ranks in a geological æon. There is nothing to prepare the scientific mind, distrustful of abrupt changes, for the adjacent excavation. Its dimensions are, from the top of the arch to the cliff above, 30 feet; to the water, 66 feet; to the bottom, 88 feet. Its breadth of 42 feet continues to within a small distance of the inner extremity, when it is reduced to 22 feet. The total length is 227 feet.

It is usually said to have been formed by erosion at the base. The columns, falling, dragged down a part of the roof, aided by a fissure which divides the ceiling. The tuff is not eroded even at the southwest end of the island. These pillars, however strong and enduring, are each composed of many separate joints or pieces, built up one upon another. They do not adhere in any way together, but merely rest mechanically upon each other, and are easily detachable. The capitals beyond cling to the roof. There is no fissure. In Boat Cave, tuff is undermined for 1,800 square feet, yet the columns stand wedged across 12 feet of width. At Tanaga Island, in the Aleutian group, the broken columns form a slightly *convex* roof across an opening 20 feet wide. No such Gothic arch was ever formed by Nature. It is strikingly Phœnician. No natural cave has an entrance higher than the interior. A tidal or earthquake wave would not reach the top of the arch. The cave is post-glacial. The upheaval of that part of Scotland is put at 25 feet. It would not bring the confused basalt within reach of the waves. Their breaching power is easily calculated. It is determined in this case by the frail wall to the east. For a merciless ocean selecting this victim of his fury, and

> "Down-bearing with his whole Atlantic weight
> Of tide and tempest on the structure's base,"

and "flashing to that structure's topmost height," in his blind frenzy would have swept through the loose drums to the right. Montalembert thought it far inferior to any cathedral, or even a monastic church such as Cluny or Vezelay. If "raising (!) a minster," it would have been better to put all the chapels under one roof. The horizontal and perpendicular sections are equally at variance with the curved surface formed by a fluid in vibration. The columnar basalt would form a

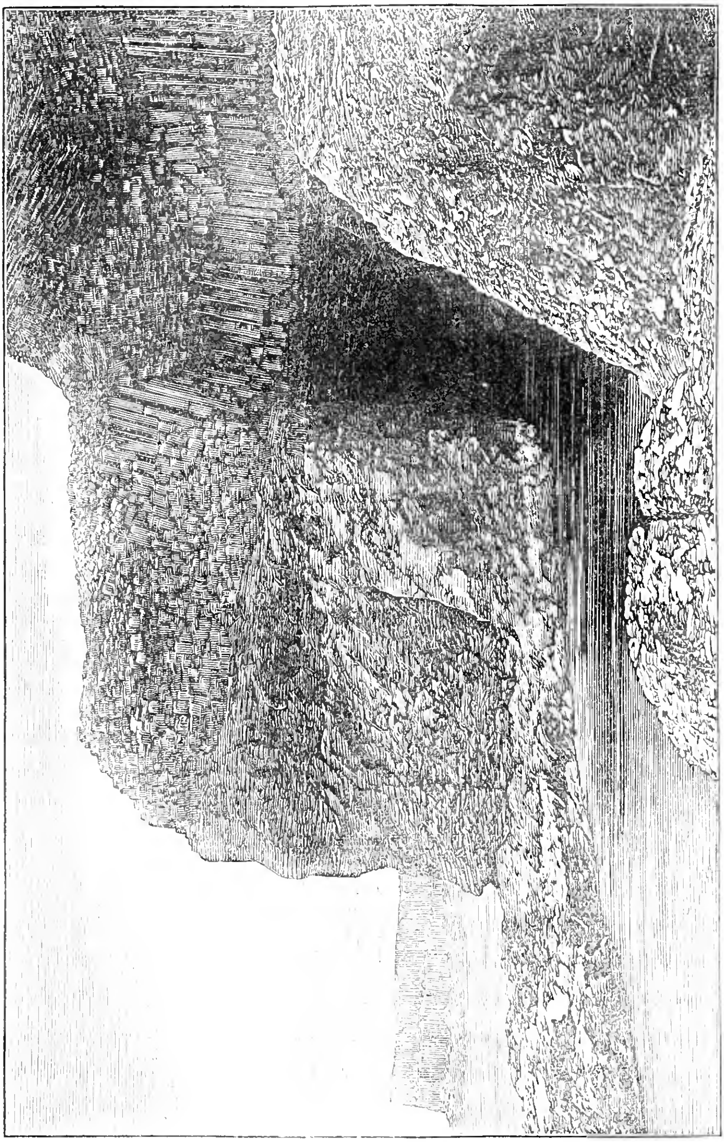

Fig. 4.—Cormorant's Cave, Staffa, 1161. G. W. W.

curved and not a rectangular water-line. What other cavern has a uniform breadth from the opening, and five and a half diameters in length?

Cormorant's or Mackinnon's Cave is easy of access, and terminates in a "gravelly" beach, where a boat may be drawn up. It is 50 feet high, 48 feet broad, and 224 feet long. It is excavated in the lower stratum. Thus two tunnels of the same dimensions are supposed to have been driven into two different materials by the same force. The interior dimensions are nearly the same to the end. As no sentimental or religious motive can be assigned to Nature for *this* freak, it is amenable to comparison. The Blue Grotto of Capri is typical. Its entrance is scarcely three feet in height; in the interior the roof rises to a height of 41 feet; the water is 8 fathoms deep; length of the grotto,

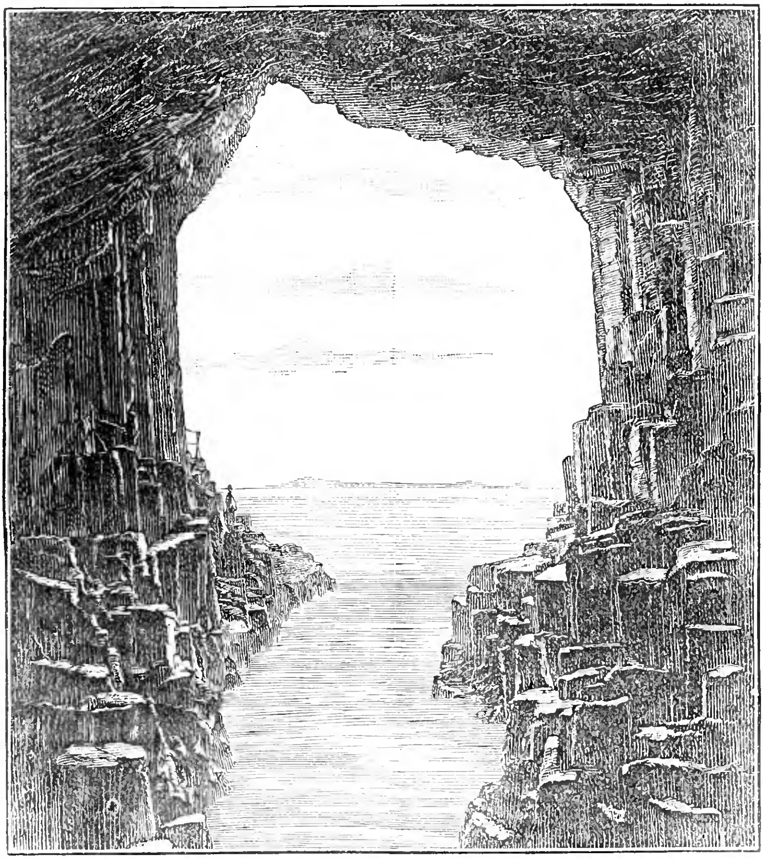

FIG. 5.—FINGAL'S CAVE (LOOKING OUT), SHOWING IONA, DISTANT SIX MILES.

175 feet; greatest width, 100 feet. Here the great size of the aperture is further increased. The superior part of the front, penetrating into the columnar basalt, has hollowed a recess above the main opening. The same Gothic tympanum, distorted by the material, not only marks its artificial origin, but disproves the allegation that the columns could not form a natural architrave. The Boat Cave is accessible only by sea. It is a long opening, resembling the gallery of a

mine, excavated also in the tuff. Its height being about 16 feet (above the sea?), its breadth 12, and its depth about 150, it offers, in its proportion of twelve and a half diameters, the greatest contradiction to all other instances of sea-worn homogeneous rock.

But not only do Cormorant's and Fingal's Cave, each protected by its breakwater, face the adjacent land and not the open sea, and that land the far-famed Island of Iona, center of art and civilization, "dear to Christendom for more than a thousand years," but from the end of this deep cavity, to which a boat may sail in any ordinary weather, the "Dun" or Hill of "Hy" or Iona rises against the sky, in the middle of the arc of a few degrees subtended by the grand doorway. Until it is shown that a thousand yards of landlocked, iron-bound coast can be cut and tunneled in utter disregard of every known law of mechanical action, the caves in Staffa, on the west coast of Scotland, driven into igneous rock, not modified by local conditions, or in the weak places "of an exposed cliff," can not be classified as merely remarkable instances of caves worn by the sea. Had the learned duke who commenced his description of Iona with these words, "No two objects of interest could be more absolutely dissimilar in kind than the two neighboring islands of Staffa and Iona," "mixed Celtic memories with the Phrygian mount," recalled Athos, Tyre, and Carthage, or even the twin Island of Lerins, he might have hesitated to put them in sharp antithesis to say that only an accident of geography could unite their names, or with "the mighty surge" of personal and social authority drowned the faint cry for relief which reached his ears, and declined even to consider the solution here offered of a problem whose complex factors he had so forcibly stated.

THE SPECTROSCOPE AND THE WEATHER.

By C. PIAZZI SMYTH,
ASTRONOMER ROYAL FOR SCOTLAND.

WHAT may be done with the spectroscope in the matter of weather is, for the present at least, confined almost entirely to the question of rain—as, Will it rain, or will it not; and, if it will, heavily or lightly? The manner in which the spectroscope accomplishes this useful part is by its capacity for showing whether there is more or less than the usual quantity of watery vapor permeating the otherwise dry gases in the upper parts of the atmosphere, this watery vapor not being by any means the visible clouds themselves, but the invisible water-gas out of which they have to be formed, and by means of which, when over-abundant, they obtain their privilege for enacting rain-fall. So that never were wiser words uttered and more terse philosophy than those which are to be found in the ancient book of Job, wherein, of the wondrously "balanced clouds" high up in mid-air, it is said, "They pour down rain according to the vapor thereof."

More or less of this water-vapor is always in the air, even on the very clearest days, and a happy thing for men that it is so; for, as Dr. Tyndall and others have well shown, it moderates the excesses of hot solar radiation by day and cold radiation of the sky at night, and is more abundant in the hotter than in the colder parts of the earth. Wherefore, according largely to its temperature for the time being, the air—otherwise consisting almost entirely of nitrogen and oxygen—can sustain, and does assimilate, as it were, a specified amount of this watery vapor, invisibly to the naked eye, the microscope, or the telescope; but not so to the instrument of recent times, the spectroscope. And if the air vertically above any one place becomes presently charged with more than its usual dose of such transparent watery vapor (as it easily may, by various modes and processes of nature), the spectroscope shows that fact immediately, even while the sky is still blue; clouds soon after form, or thicken if already formed, and rain presently begins to descend.

But how does the spectroscope show to the eye what is declared to be invisible in all ordinary optical instruments? It is partly by its power of discriminating the differently colored rays of which white light is made up, and partly by the quality impressed on the molecules of water at their primeval creation, but only recently discovered, of stopping out certain of those rays so discriminated and placed in a rainbow-colored order by the prism and slit of the spectroscope, but transmitting others freely. Hence it is that, on looking at the light of the sky through any properly adjusted spectroscope, we see, besides the Newtonian series of colors from red to violet, and besides all the thin, dark Fraunhofer, or solar originated lines, of which it is not my object now to speak, we see, I say, in one very definite part—viz., between the orange and yellow of that row of colors, or "spectrum," as it is called—a dark, hazy band stretching across it. That is the chief band of watery vapor; and to see it very dark, even black, do not look at a dark part of the sky or at black clouds therein, but look, rather, where the sky is brightest, fullest of light to the naked eye, and where you can see through the greatest length of such well-illumined air, at a low, rather than high, angle of altitude, and either in warm weather, or, above all, just before a heavy rain-fall, when there is and must be an extra supply of watery vapor in the atmosphere. Any extreme darkness, therefore, seen in that water-vapor band beyond what is usual for the season of the year and the latitude of the place is an indication of rain-material accumulating abnormally; while, on the other hand, any notable deficiency in the darkness of it, other circumstances being the same, gives probability of dry weather, or absence of rain for very want of material to make it; and the band has, therefore, been called, shortly, "the rain-band." Thus, also, "rain-band spectroscopes" have been specially constructed by several most expert opticians in size so small as to be carriable in the waistcoat-pocket, but so powerful and true that a glance of two seconds' duration through one of them suffices to tell an experienced observer the general condition of the whole atmosphere. Especially, too, of the upper parts of it, where any changes—as they take place there almost invariably earlier than below—enable such an observer to favor his friends around him with a prevision of what they are likely soon to experience.

As an example of what may be done, and done easily, after a certain amount of experience and understanding of the subject has been acquired, I append, from a lady's meteorological journal, her notes of the mean temperature of the air and the intensity of the rain-band for each of the first fifteen days of the present month, and in a final column have entered the amount of rain-fall measured at the Royal Observatory, Edinburgh, on each of those days. The darker the rain-band the larger is the figure set down for it, and it will be seen pretty plainly, on running the eye down that column and the next one, that with an intensity of either 0 or 1 no rain follows, or, we might almost say, can follow; but with an intensity of 2 rain-fall begins, and with 3 it may be very heavy. All these rain-band notes have been made with a spectroscope no larger than one's little finger, purchased some six years ago, and taken on many voyages and travels since then:

DATE, SEPTEMBER, 1882.	Mean temperature of the air.	Rain-band intensity.	Depth of rain measured in gauge at Royal Observatory, Edinburgh.
	Deg. Fahr.		Inch.
Friday, 1	57·1	3	·044
Saturday, 2	59·2	2	·353
Sunday, 3	58·6	2	·015
Monday, 4	54·4	0	0
Tuesday, 5	55·7	1	0
Wednesday, 6	55·2	0	0
Thursday, 7	53·8	1	0
Friday, 8	59·4	0	0
Saturday, 9	54·0	1	0
Sunday, 10	57·0	1	0
Monday, 11	52·2	1	·040
Tuesday, 12	48·6	0	0
Wednesday, 13	52·8	1	0
Thursday, 14	49·5	3	·62
Friday, 15	56·2	2	.570

But, if so much can be done by so small a spectroscope, the question may be well asked whether more still might not be accomplished with a bigger and more powerful one, especially seeing that the dispersive powers of both chemical and astronomical spectroscopes have in late years been increased to a most astonishing extent. The question is important, and somewhat new as well. I propose, therefore, to devote the remainder of my space to its answer, rather than to the practical rules for using the smaller instruments, especially, too, as they have been already introduced to the public, both by my friend Mr. Rand Capron, in his pamphlet "A Plea for the Rain-band," and by myself, in the fourteenth volume of the "Edinburgh Astronomical Observations"; also in the "Journal of the Scottish Meteorological Society," and in the September number of the "Astronomical Register for 1877."

The greater part of higher power spectroscopes are not suitable to rain-band work, for their fields are usually too dark. But having recently built up for myself a large-sized variety of the instrument, possessing perhaps the greatest combination of power with transparency yet attained, and having it always mounted in an upper chamber looking out at an altitude of about 5° over the northwestern horizon (or most suitably for rain-band work), I will try to describe shortly its action therein.

The classical "rain-band," which in the little instrument is merely a very narrow fringe to an almost infinitely thin black line, is so magnified laterally in the larger instrument as to fill the whole breadth of the field. The thin black line before spoken of is now not only split into two, but these are both strong, thick, sharply defined lines, separated from each other by six or seven times the breadth of either. These are the celebrated solar D-lines, D1 and D2, arising from the sodium metalloid burning or incandescent in the sun. They are, therefore, perfectly uninfluenced by changes of the terrestrial atmosphere, hot or cold, wet or dry, and are, therefore, invaluable as references for degree of visibility of the water-vapor lines and bands which rise or fall in intensity precisely with those changes. There are several of these earthly water-vapor lines and bands in and between and about the D-lines themselves; then a long breadth of band toward the red side of D1; then a pair of lines not so widely apart as the D-lines, but sometimes just as sharp and black; then two or three fainter bands; then a grand triple, of which the nearer line sometimes attains greater blackness than either D-line; then beyond that three distinct, equal-spaced, isolated bands; and, farther away toward the red, a stretch of faint haze and haze-bands.

All these go to make up the one thin rain-band of the little spectroscopes; and I fortunately had, through the month of August and the early days of September, occupied myself each morning in noting the greater or less intensity of each and all these water-vapor lines and bands in terms of the two solar constants D1 and D2; and every such morning there was an abundance of details to see, to recognize, and to measure. But on the morning of Monday, September 4th, when the little instrument had truly enough marked 0 on its very small scale, I almost started at finding in the large instrument every member of its long rain-band group, unless it were a vanishing trace of one or two of the strongest, utterly gone; while the two D-lines were in their accustomed strength, but far greater clearness, for now they were all alone in the field save the ultra-thin solar nickel line between them and one or two others, equally thin and solar on their blue side. The stages of perceptible shade of water-vapor lines which had thus been swept away, between their this day's invisibility, and their tremendous strength no longer before than the previous Friday, might have been expressed by a scale not divided into three parts only, but into thirty; and implied such a very unusual amount of absence of water-vapor, that I not only felt sure of no rain falling either next day, or perhaps for several days after, but that the weather must also be coming on colder as well. Therefore it was that I took the step of instantly writing as I did to a local paper, promising the perplexed farmers dry weather at last, though probably sharp and cold, to get in their crops.

And how was that expectation fulfilled? Various meteorologists in different parts of the country have already declared themselves well satisfied with it. But I would now beg further attention to the little daily register already quoted, showing that from and including that day, Monday, September 4th, up to and including the next Saturday, not a drop of rain fell at the observatory. Between the following Sunday and Monday, a drizzle, but only amounting to 0·04 inch, occurred, and after that there were three more days equally dry with the preceding ones. But on Thursday, the 14th, the rain-band reappeared in both spectroscopes in all its force; rain began to fall the same day, and next day's measure at the observatory amounted to more than half an inch. Wherefore it is to be hoped that the farmers had busied themselves effectively while the dry weather lasted, for the return of these spectral lines of watery vapor showed that their autumn opportunity was then gone by.—*London Times.*

CRIMINALITY IN ANIMALS.

By A. LACASSAGNE,

PROFESSOR OF LEGAL MEDICINE IN THE FACULTY OF LYON.

It is a recognized fact that the anatomy and physiology of animals have afforded valuable help in the study of the human constitution. We might, indeed, say that physiology, toxicology, and therapeutics are based upon experiments which have been made on animals. Why, then, have we halted at this stage? Why has it not occurred to medical experts in criminal law to study the phenomena of crimes among animals for the purpose of reaching a better understanding of those which are committed by men? If animals are liable to the greater proportion of the organic maladies to which we are subject, if they are liable to epidemic or contagious diseases, there appears to be no reason why they should be exempt from mental diseases. Just as we recognize that there occur among men malformed individuals, organically defective and furnishing proofs of their organic faults in their acts, feelings, or thoughts, so we should expect to find similar individuals among animals, or at least among those species which stand constitutionally nearer to man.

Two causes may be alleged for the neglect of this study: First, animal psychology has not yet made much progress. The investigations of veterinary physicians have not been directed to that side. Pierquin said, in his "Traité de la Folie des Animaux" (Treatise on Madness among Animals), in 1839, that till his time no professor of veterinary medicine had ever spoken from his chair, either of the brain, the nervous system, or the physiology of animals. The other cause, and the most influential one, has been the difficulty most authors have had in disembarrassing themselves of the scholastic ideas which have promoted the belief in a great chasm between the moral condition of animals and of men. As Gall has well said, the greatest obstacle that it has ever been possible to oppose to the knowledge of human nature consists in the fact that theorists have isolated it from that of other beings, and endeavored to subject it to laws of its own, different from those of their nature. He adds, subsequently: "Those who account for the normal and intellectual acts of man, of the understanding and of the will, independently of the body, and those who, being wholly strangers to the natural sciences, still believe in the mechanism or the automatism of brutes, may find the comparison of man with animals revolting and absolutely sterile. But such a comparison will be regarded as indispensable by those who have familiarized themselves with the labors of Bonnet, Condillac, Reimarus, Georges Leroy, Dupont, Nemours, Herder, Cadet Devan, Huber, etc., and especially by those who have become ever so slightly acquainted with the progress of comparative anatomy and physiology."

The authors who are cited by Gall have furnished important data for the comparison of animal species, and have laid the foundation of a scientific comparative physiology. Buffon had already asserted that, if no animals existed, the nature of man would be still more incomprehensible than it is. The observations of Georges Leroy and Gall have shown that the elementary functions of the brain must be investigated in the study of animals. These authors have been followed in this way by Prichard, Pierquin, Darwin, Forel, Espinas, Houzeau, Büchner, etc., from whom and from other naturalists and travelers, the materials for this essay have been largely borrowed.

The present work was suggested to me by Professor Lambrozzo, of

Turin; and Professor Cornevin, of the veterinary school of Lyons, has furnished me several valuable facts.

By way of an historical introduction to our study, we will cast a glance at the relations which the human laws of different societies have established between men and animals. The primitive peoples, fetichistic in their feelings and habits, and not yet capable of metaphysical subtilties, instinctively put animals and men upon a footing of perfect equality as respected the penalties to be attached to their crimes. It was so with all people during the middle ages, and even in fact down to the last century. Then, by one of the sudden contradictions which frequently appear in the history of mankind, a distinction between the actions of men and of animals was clearly defined. The powerful influence of Descartes, the encyclopedists, and the scientific men of the last century, who were more frequently demolishers than constructors, affords the explanation of the change, which, it is proper to say, was due rather to bad than to generous sentiments. Gradually, under the domination of the metaphysical spirit, the conviction arose that animals were brutes, that it was difficult to appreciate their moral state, and that this moral state was after all separated, if it had any existence, by an immense distance from that of man. So the law protecting animals was quite forgotten in the framing of our codes.

Only a few scientific men or observers made approaches to the admission of evolution and transformation. These ideas have become common now, and nearly every one has adopted them theoretically, but few admit them in practice, and it will not be surprising to us if the title of our essay raises a smile on the face of many of its readers.

We will begin by showing how the human societies that have preceded ours have manifested their feelings with regard to certain acts of animals. Among fetich-worshiping peoples, the animal is considered as a man, and a member of the human family to the same extent as a slave. Its loss is an occasion for mourning, and its trespasses—toward man—deserve punishment.

In ancient Egypt, when a cat died in the house, the inhabitants shaved their eyebrows; if a dog died, they shaved their whole body. In Athens, one of the laws of Triptolemus declared that no one had a right to inflict a wrong upon a living creature. The Greeks were aware of the tender and affectionate care which the young of the stork exhibited for their old parents, and recorded that, when the latter lost their feathers from age, the young stripped themselves of their down for them and fed them with the food they collected. This was the origin of the Greek law called "the law of the stork," by virtue of which children were obligated to take care of their aged parents, and those who refused to do so were declared infamous. How different is it in our modern societies! Pierquin remarks with reason that, as man rises, he treats animals as if they were correspondingly degraded.

For a long time they had the same rights. During the middle ages they were allowed a part in religious ceremonies. At Milan they figured in the festivals of the kings; and processions of animals appear in the bas-reliefs of the cathedrals of Strasburg, Mans, and Vienne (Isère). On Holy Wednesday all the clergy of the church of Rheims went to Saint Remi to make a station there; the canons, preceded by the cross, were arranged in two lines, each drawing a herring after him with a cord; and each one was intent upon saving his own fish, and stepping upon that of the canon in front of him (Anquetil, "Histoire de Reims"). At Paris, the procession of the fox was as much enjoyed as the festival of the ass. The animal, dressed in a kind of surplice, wearing the mitre, had his place in the midst of the clergy: a fowl was put within his reach; he often forgot his pious functions to spring upon the bird and devour it in the presence of the faithful. Philip the Fair was very fond of this procession (Sanval, "Antiquités de Paris"). Only a few years ago, the procession of the fat ox remained, a survival from the pagan feasts, a real piece of wreckage from vanished civilizations.

While the rights of animals were thus recognized, their duties toward man did not escape the earlier legislators, who severely punished their crimes and attempts upon human life. The law of Moses (Exodus xxi, 28, 29) recites: "If an ox gore a man or a woman, that they die: then the ox shall be surely stoned, and his flesh shall not be eaten; but the owner of the ox shall be quit. But if the ox were wont to push with his horn in time past, and it hath been testified to his owner, and he hath not kept him in, but that he hath killed a man or a woman; the ox shall be stoned, and his owner also shall be put to death."

Judgments based on this principle are recorded at Athens and Rome. According to Pierquin, Democritus wished an animal, which had occasioned some major damage, to be punished with death. Under Domitian, according to the report of Martial, the ingratitude of a lion toward its master was severely punished. Columella and Varro say that the ancient Romans regarded the ox as the companion of the labors of man, and that the act of killing one was regarded as a homicide and punished in the same way; and the ox enjoyed the same privilege in Attica and the Peloponnesus. It is also said that the Arabs in the mountains of Africa formerly crucified lions, guilty of murders, upon trees, as warnings to others.

In the middle ages they prosecuted animals which committed murder, those which had become dangerous to have at large, and females which, having given birth to monsters, were suspected of criminal cohabitations. Père Théophile Raynaud, Ayrault, Gaspard Bailly, and more recently M. Benoist Saint-Prix and M. Louandre ("Epopée des Animaux," "Revue des Deux Mondes," 1854), have cited some extremely curious examples of such condemnations.

In 1120 the Bishop of Laon issued a letter of excommunication against the caterpillars and the field-mice. Under Francis I an official advocate was provided for these animals, and pleadings were allowed between them and the farmers. In 1356, at Falaise, a sow having killed a child and begun to devour it, the judge condemned it to perish by the sword. As it had eaten an arm and part of the head of the child, one of its feet was cut off and its "face" was mutilated. Then it was dressed in man's clothes before being led to punishment, and the executioner received his customary fee of ten sous and a pair of gloves. In 1543 the consuls and aldermen of Grenoble published a decree demanding the excommunication of the snails and caterpillars. In 1585 the Grand Vicar of Valencia ordered the caterpillars, with which the country was infested, to evacuate his diocese. In 1587 an action was brought against the insects which were ravaging a field near Saint Jean de Maurienne, and they were condemned. Jean Milon, an officer of Troyes, pronounced the following sentence on the 9th of July, 1516: "Having heard the parties, and granting the request of the inhabitants of Villenove, we admonish the caterpillars to retire within six days; and, in case they do not comply, we pronounce them accursed and excommunicated."

M. Benoist Saint-Prix has collected eighty sentences of death and excommunications that were pronounced between 1120 and 1741 against every species of animals, from the ass to the grasshopper. He adds that, while in some countries animals have been employed as executioners, they have frequently been admitted in France as witnesses in suits. Who does not remember the history of the dog of Montargis, and the duel that Charles V ordered to be fought between the faithful animal of Aubrey of Montdidier and the assassin of his master, Richard Macaire?

The recital of these facts and a comparison of what has taken place in our time permit us to appreciate the great modifications that have been produced in the feelings of mankind. We have furthermore learned that, until our epoch, an erroneous idea prevailed regarding the offenses or crimes committed by animals. The actions of animals toward other animals had passed almost unperceived, and did not seem worthy of being noticed. It could not, therefore, enter the head of any person to investigate their moral bearing. The animal was adjudged and punished only when his offense bore upon man or society.

It appears to us that the time has come for a scientific study of certain criminal acts of animals, for the purpose of comparing them with similar acts committed by men and punishable by our laws. It is a study in comparative criminal psychology. We believe that such a work may have a higher bearing than that of a mere effort of scientific curiosity; and it seems to us, with Georges Leroy, that the moral condition of wolves may throw light upon that of men.

According to Georges Leroy, three motives influence the animal and become the principles of his thoughts, his judgments, his determinations, and his actions. They are the seeking for food, the taking of precautions for his safety, and the gratification of his amorous desires. Leroy also suggests that we may recognize in beasts natural passions, and other passions which might be called factitious or reflexive. Of the former class are the impulses of hunger, the ardent desires of love, and maternal tenderness; of the latter are the fear of want, or avarice, and jealousy, which leads to vengeance. Other authors, among them Gall and August Comte, have endeavored to frame a classification of the cerebral faculties. Without discussing here these different systems which have been proposed chiefly to fix the number of man's elementary faculties, we believe that it will be convenient for the exposition of our subject to recognize among animals such instincts or elementary faculties as the nutritive, the genetic, the maternal, and the destructive instincts; and, as among those easier to establish with man than with animals, the instinct of vanity and the social instincts. We shall study particularly the exaggerations of these instincts, which are injurious to other animals of the same species, and which result in such specific acts as are regarded as crimes or offenses in human societies. "The animal and man," says Gall, "are organized for anger, hatred, sorrow, fear, and jealousy, because there are things and events which, according to their nature, deserve to be detested or loved, desired or feared."

1. Acts of Offense committed by Animals under the Influence of the Nutritive Instinct.—No distinctions are observed with regard to sex. When hunger makes itself felt, all animals exhibit, in different and varied degrees, according to their nature, the spectacle of the "struggle for existence." The fact is so well known that it does not require any great elaboration. The animals longest and most completely domesticated continue at feeding-time to steal food from each other, and to quarrel about it. The use of separate mangers, racks, boxes, and stalls, is based upon the knowledge of this fact. The object of the most important features of the interior arrangements of stables is to prevent the stealing of food and the trampling of the weaker by the stronger. It is well known that among the species which we see daily are individuals manifesting clearly the disposition to theft. Some of them have an exaggerated nutritive instinct, are avaricious, and lay up provisions. Leroy says that when wolves have brought down a large animal, they eat a part of it and carefully hide the rest; but this precaution does not abate their propensity to hunt, and they have recourse to their *cache* only when the chase has been unsuccessful. The same observation may be made with reference to dogs, foxes, and other animals.

M. Cornevin has remarked that, among species which live in community, not only is food stolen, but individuals which are on the point of perishing are eaten. Wolves, in spite of the proverb, rats and mice, eat each other up. "Last year I observed several times among the Guinea-pigs, which were the subjects of my experiments, that those that died were eaten by the survivors. They were not troubled by hunger, for they had all the corn they wanted. Possibly they sought to appease their thirst in the blood of their victims." Büchner, in his psychical lives of beasts, speaks of thievish bees, "which, in order to lessen their labor or dispense with it wholly, made attacks in mass upon provisioned hives, committed violence against the sentinels and the inhabitants, pillaged the hive, and carried away all the store of honey. If this exploit was successful for several times, they, like men, acquired a stronger taste for pillage and violence than for work, and ended by constituting real colonies of brigands." There are isolated individuals which are addicted to theft, and endeavor to slip, without being perceived, into a strange hive; their sly tricks demonstrate that they are forced to concealment, and are conscious that they are transgressors. If they succeed in their attempt, they afterward bring other bees to their hive to tempt them to similar thefts, and thus form a society of thieves. Büchner adds that bees may be artificially made thieves by feeding them a special food consisting of honey mixed with brandy. "Like man, they readily acquire a taste for this beverage, which exercises the same pernicious influence upon them as upon him; they become excited, intoxicated, and cease to work. Do they feel hunger? Then, like man, they fall from one vice into another, and give themselves up unscrupulously to pillage and theft."

2. Acts of Offense committed by Animals under the Influence of the Genetic Instinct.—Such acts may be distinguished between those committed by the male and those committed by the female. The former are more frequent and violent than the latter. Some animals indicate a feeling of decorous modesty, while others are absolutely shameless. Without going into details on this subject, it may be considered sufficient here to remark that most of the sexual offenses which have been defined by the law or put under the ban of human societies may be observed among animals in their intercourse with each other; and instances are on record in ancient and modern history, though rare and not always well authenticated, of attempts by animals against human beings.

3. Acts of Offense committed by Animals under the Influence of Maternal Love.—The exceedingly marked development of this instinct in female animals well justifies the epithet maternal.

Gall has remarked that while the instinct for propagation is extremely ardent among the males of certain species—the cock, the dog, the boar, and the stag, for example—without the animals taking the slightest interest in the young, the instinct for propagation is also generally more active in the male than in the female, and generally, also, the female feels a stronger love for the offspring. Many animals, as among the insects and amphibiæ, and the cuckoo, take no care at all of their young, although they mate ardently.

Other animals, as with ants and bees, do not exercise the act of propagation at all, yet they very assiduously take care of the eggs and larvæ. The same author insists upon individual differences, and cites cases, the counterparts of which would be called in human societies abandonment of children, abduction of minors, seduction, infanticide, etc.

Some cows, mares, and dogs bear the loss of their young with a degree of indifference; others even abandon them regularly. Pigeons generally, male as well as female, appear indifferent to their broods, while the rail and the corn-crake are so devoted to them that their heads are frequently cut off by the reaper's sickle. When a house in which storks have a nest takes fire, the father and the mother stork will fall into the flames rather than abandon their young. Boerhaave has made the same observation with respect to the chimney-swallow. The female partridge loves her own young with a strong affection, but she chases away and kills the young of other partridges. The pheasant, on the other hand, shows much less affection for her own young, and does not mind the loss of those which stray from her, while she receives joyfully and takes under her protection little pheasants that are strangers to her.

Gall tells of mares that have such a passion for colts that they kidnap the foals from other mares, and take care of them with a jealous fondness; and Espinas notices the same fact among asses. Pierquin had a dog of a Scotch breed, which was shy of the male, but would capture every puppy it met, and was in the habit of stealing out of the house to go hunting for them.

Among facts of an opposite character, we cite the case of a friend's dog which bore three or four litters, of which it would take proper care during the first three months, and would then carry them away into the mountain and leave them. We must also take notice of that inexplicable aberration that leads many females among our domestic animals to suffer their progeny to die, or kill them; while other animals, dogs, for example, become thieves during the whole time that they are taking care of their young. Females of the larger domestic species frequently refuse to let their young suck them, with the result that the young die. This is most remarked of animals bearing for the first time. The most astonishing fact is that of infanticide, which is almost the rule with certain species, notably with swine.

4. Acts of Offense committed by Animals under the Influence of the Destructive Instinct.—This instinct acts when animals are urged to overcome the obstacles that oppose the satisfaction of their desires. Thus they become murderous in time of heat; they seem to have gained new force; their nature has become irascible and furiously disposed; and contests of the most bloody character take

place between them. Pierquin adds that baffled love often leads man as well as animals into a murderous monomania. Buffon cites examples of animals which were frequently subject to a murderous passion. He speaks of canary-birds which were so wicked as to kill the female that was given them, and which could not be broken of the practice except by giving them two. Others are so barbarous in their inclinations as to break and eat the eggs as soon as they have been laid; and, even if the unnatural father allows the eggs to be sat upon, he will kill the young as soon as they are hatched. Pierquin mentions cross, quarrelsome dogs that are always ready to fight upon the smallest provocation. Wickedness of this kind may be manifested in certain races; it may be individual, permanent, and hereditary; or, while it is still individual, it may be accidental and transient, provoked by particular circumstances.

We may call a specific malignity that which one species shows toward another species that hunts it or is its rival in the struggle for existence. The instinctive repulsion of dogs and cats is proverbial. It is interesting, however, to observe how this repugnance can cease under certain conditions, as when the struggle for existence becomes less active. Commander Mouchez asserts that the cats and the rats on the Island of St. Paul, where he went to observe the transit of Venus, have ceased to war upon each other, and have instead joined in hunting birds. Cases of permanent and hereditary maliciousness are not rare. All who have had to do with domestic animals, says M. Cornevin, have observed that there appear among our subdued species, horses and cattle, individuals, both male and female, which are intractable, vicious, and absolutely useless; just as individuals of a similar character sometimes appear in human society. Such traits are often hereditary.

We have examples of the excitation of the destructive propensity by higher faculties in which malice seems to be consecutive to a real reasoning. First among them is the case of malice aroused by the recollection of bad treatment. Animals with such passion become murderers for revenge. They say that the mule always keeps a kick in store for the master who maltreats it; and examples are frequent of asses, mules, and horses, that were very gentle till they were chastised, remembering the blows they had received, and avenging themselves on the drivers who inflicted them. There are also murderers for rivalry. A bull that has been gentle enough as long as he has had his cows to himself will become vicious as soon as a rival is brought into the field, and will try to kill him or drive him away, and always keep watch over him.

M. Colin, in his treatise on the "Physiology of the Domestic Animals," cites two curious examples of criminality developed under the operation of the nutritive instinct. A dog at the school of Alfort, which was fed on the remains of dissected bodies, conceived a violent and dangerous hatred for the skinner, who took away his meats. Another dog, which was fed together with a hog, took such aversion toward his commensal, that he broke his chain, jumped upon the porker, killed, disemboweled, and tore it.

Man has sometimes taken pains to develop the destructive instinct of animals. Jacolliot tells of elephants that were fed with meat to keep this faculty in a state of excitation. The Hottentots train cattle in a similar way. A legend runs to the effect that an exiled king of Garamanta returned to his country with an army of two hundred dogs. It is said, also, that when the Cimbri were defeated their dogs defended their chariots. The city of St. Malo is said to have been defended once in a similar manner; and during the night the animals were let loose in the streets as a kind of police. At the camp of Lobau, during the campaign in Italy, the soldiers trained large dogs to take prisoners. Watchmen in some prisons are accompanied in their night-rounds by dogs, to detect the prisoners who are out of their beds.

5. Acts of Offense committed by Animals under the Instinct of Vanity.—Though less susceptible than man, animals are very fond of praise and approbation. With what intoxication of joy does the dog receive our commendations! Every one has remarked how sensible horses are to marks of affection, and how they exert themselves in races so as not to allow a rival to pass them. Pierquin had a monkey which, when a handkerchief was given it, draped itself in it, and manifested an extraordinary pleasure in watching the train of its court-robe. Napoleon believed that man was only a more perfect animal, and claimed for his horse memory, intelligence, and love. "I had a horse," he said, "which could recognize me among all the world, and which showed, by his prancing and his proud step when I was on his back, that he knew he was carrying a person superior to all the others around him. He would not allow any one else to ride him except a groom who regularly took care of him, and his movements, when that man was upon him, were so peculiar that he seemed aware that he was carrying a servant." This was perhaps the same animal of which Constant wrote in his "Memoirs": "The Emperor had for several years an Arabian horse of rare instincts, that gave him much pleasure. It was hard to discover any grace in him while his master was out of sight, but whenever he heard the drums announcing the presence of his Majesty he would raise himself in pride, shake his head, paw the ground, and from that moment till the Emperor dismounted from him he would carry as fine a head as ever was seen." Such vanity is, in fact, quite common among Arabian horses, and the treatment they receive is well adapted to develop it. It is comprehensible that, under the influence of this instinct, and the jealousy that often results from it, animals may become malicious and quarrelsome, and attack and even kill their companions. It has been

remarked that these vain animals more readily attack ragged creatures, especially if they dwell where they are unaccustomed to the sight of misery.

6. Acts of Offense committed by Animals under the Influence of the Social Instincts.—Such social instincts as attachment and reverence can not be found among all animals. They evidently can not exist among animals which live isolated, or among those which mate only temporarily. It is otherwise, however, with those that live together, and between these a real marriage is established. So, when several couples or families have a common habitation, elevated social bonds are produced, quite comparable to those which are established in human societies. Examples will not be wanting, if we look at the bees and the ants, or at the republic of the rabbits. The idea of property, says Georges Leroy, certainly exists among rabbits; old age and fraternity are much respected by them.

Doves, turtle-doves, the roe, the chamois, and the mole can not support widowhood, and death generally follows the loss or absence of one of a pair of them. Some curious stories are told of the conjugal customs of storks. The males seem to be very jealous, and sometimes put to death an unfaithful companion and her betrayer. The inhabitants of Smyrna, who are well acquainted with the conjugal susceptibility of the male stork, amuse themselves by putting hens' eggs into the nests of these birds. The male becomes very angry at the sight of this unusual product, and, with the aid of other storks, tears his companion to pieces. There is certainly no need of calling up the numerous facts that show that domestication has, in certain animals, dogs, for example, developed these social instincts into a most touching devotion.

It seems to us that the review we have just made embraces a sufficiently large number of facts to permit us to establish an almost complete parallel between the criminal actions of men and those of animals. The analogy would have been closer if we had cited examples of tricks to show what combinations or means are at the disposition of an animal when it is seeking to accomplish its purposes. We can not, however, help remarking that there are authentic cases of simulation or deception which animals have worked out to save themselves from labor or to procure some advantage. A military surgeon tells of a horse which was accustomed to pretend to be lame on the days when the horses were drilled, in order to avoid that duty. Coste mentions a dog which, in the winter, when he found his comrades lying around the fire in such a way as to prevent his getting near to it, would make a great noise in the yard; at this the other dogs would run out, while he would slip into the house and, securing a good place for himself, leave his comrades to bark as long as they pleased. He tried this trick quite often, and always succeeded in it, for the other dogs had not intelligence enough to find it out.

With men, certain crimes tend to diminish or disappear under the influence of civilization. It is the same with animals. The more the domestication of a race is perfected, the less violent do its passions become, and, consequently, such crimes as we have discussed grow more rare. Not being troubled about their food, which is put before them in abundance and good order every day, they are not subject to the struggle for existence, and their character is mollified. Furthermore, by virtue of the law of organic balance, the development of the digestive apparatus, consequent on plentiful and regular feeding, takes place at the expense of the nervous system, whence less violence, less irritability, and less sexual passion. Malice is extremely rare among thorough-bred domestic animals, as, for instance, among the Durham cattle.

A man subject to relapses—this is his forty-fourth sentence—a man of quite solid education, yet who seems to pursue persistently the most absurd of evil schemes, wrote to me a little while ago: "I committed the first offense in my life, then repaired it. Repulsed everywhere and by every one, I pretended to steal, so that I could be arrested and condemned. All my condemnations have been for vagrancy or breaking my parole. I have always behaved well when I have had enough to eat. Misery makes a man wicked. With a piece of bread one may, perhaps, prevent a wretch from committing theft or murder." The criminal, says Hobbes, is a robust child; and Georges Leroy adds: "If we suppose a man to have strong desires, and to be without experience, like a child, it is hard to conceive of anything that will restrain him in the course he is pursuing. Our passions bring us back to childhood by vividly presenting to us a single object with the degree of intensity that eclipses everything else."

We believe that we have shown in this study that, if the acts, the thoughts, and the feelings of animals are similar to ours, the same is the case with their offenses and their crimes, so far as the same are related to their interests and their passions. As in our own species, the criminal animal is generally a type appearing sporadically, with passions, desires, and instincts that are not those of its race. These faults are transmissible and hereditary. Domestication and systematic feeding diminish, destroy, or transform these mischievous dispositions. We were right in saying, when we began, that the morals of wolves may throw light upon those of men.—*Revue Scientifique.*

SKETCH OF MATTHIAS JACOB SCHLEIDEN.

"TWO names," says M. Leo Herrera, in the "Revue Scientifique," "are inseparably connected with that grand movement of the biological sciences that began about 1838, and of which we to-day contemplate the superb bloom—Schleiden and Schwann. The two laid the foundations of the cellular theory. Both exercised a powerful influence over their contemporaries; both rendered lasting services to science through their teaching, their pupils, their ideas, and even through their errors."

Schleiden devoted himself variously to law, medicine, the natural sciences, and philosophy, and his works bear the marks of those diversified studies: but he was, above all, a botanist; it was under this title that he became famous, and by this his name must endure.

Matthias Jacob Schleiden was the son of the physicist, Andreas Benedict Schleiden, and was born in Hamburg, April 5, 1804. On quitting the gymnasium he entered upon the study of the law at Heidelberg in 1824. He received his degree in 1827, and had entered upon the practice of his profession in his native city, when, in 1831, he concluded that the natural sciences were more to his taste than the law. With the encouragement of his father, he returned to the university, and studied medicine at Göttingen—where he enjoyed the instructions of Bartling in botany—and the natural sciences at Berlin, where his uncle, the botanist Horkel, enlisted his special interest in that branch. In 1839 he was appointed, on the recommendation of Humboldt it is said, Adjunct Professor of Botany at Jena, where he continued to teach in the chair of that science till 1862.

Schleiden was thirty-three years old when he published his first works; the scientific collections from 1837 to 1852 contain twenty-seven memoirs contributed by him. The most striking of these essays and the ones which contributed most directly to his rapid rise to eminence, were those in which he propounded his theories of the origin of plant-cells and of fructification. These were the "Beiträge zu Phytogenesis" ("Contributions to Phytogenesis," 1838), and "Ueber Bildung des Eichens und Entstehung des Embryos beim Phanerogamen" ("On Formation of the Ovule and Origin of the Embryo in Phanerogams," 1839)—his "most remarkable, most revolutionary, and most erroneous works," which astonished the world, "just as he had barely made himself known by a few anatomical and organogenical researches." Both of these works called forth lively responses. They were translated into English and French. They were commented upon and discussed, and were the subject of passionate debates; in short, inquiry was awakened, and an impulse was given to investigation, the force of which has not slackened to this day.

The theory of cells, as given in the "Phytogenesis," may be briefly stated as follows: There are two points in a plant well adapted for a ready and safe observation of the production of a new organization; these are the embryo-sac and end of the pollen-tube (according to his fertilization theory, the first cells of the embryo should form there, while in reality this is not the case). At both points, the formation of nuclei causes turbidity in the homogeneous gum-solution—these increase in size, and soon cytoblasts (a granular coagulation) appear. In the free state the cytoblasts increase rapidly until they attain a certain size, when they are surmounted by a fine diaphanous bubble; this is the young cell, at first a segment of a sphere, its plane side formed by cytoblasts, and its convex side by young cells (the cell-epidermis) similar to a watch-crystal on a watch. Gradually the bubble expands, becomes more consistent, and the wall is composed of cytoblasts and of a gelatinous substance. The cell grows, overlaps the cytoblasts, and then increases so rapidly that the cytoblast appears as a small nucleus inclosed in a duplicature of the cell-wall. As the growth progresses, the mutual pressure, exerted by the cells upon one another, causes a certain regularity of form, frequently that of the rhombendodecahedron. Only after the resorption of the cytoblasts the formation of secondary deposits begins on the inner surface of the cell-wall. Schleiden assumes the process thus described to be the general law of formation for the vegetable cell-tissues in the phanerogams. This theory was conceived while Schwann was still engaged with his theory of the origin and propagation of animal cells. Schwann has, in fact, acknowledged in his "Microscopic Researches" that Schleiden communicated his observations on the subject to him before publishing them, and thus gave him the light that showed him the way to his own results. So it has come to pass that, by means of the joint labors of these two men, the cell has been recognized as the peculiar element in both kingdoms of organic nature, and all the processes of vegetable and animal life have been located in its little laboratory.

Schleiden's theory has been proved to be a premature generalization, based upon incomplete and inaccurate observations, and has been refuted by Nägeli; but, incorrect and of little consequence as it was in itself, it has also proved to be the grain of ferment which has worked a transformation and revivification of biological science.

Schleiden's theory of fructification was announced just at the time (1839) when those who denied sexuality in plants had seemed to carry the day, and all botanists had agreed, to use the language of M. Herrera, in attributing the production of the embryo to the ovule, while allowing to the pollen only a simple action of fertilization. "All at once a botanist, already celebrated, proclaimed that he had seen the embryo forming in the grain of pollen and penetrating the ovule with the pollenical tube. This unexpected animalculist was Schleiden. His animalculism was, however, limited to the vegetable kingdom. He did not aspire to extend it to the other kingdom. To explain the contradiction which thus appeared between the fecundation of animals and that of plants, he regarded the vegetable ovule as a male organ, and the grain of pollen, producer of the embryo, as a female organ. The announcement of this discovery came like a clap of thunder. It soon had enthusiastic partisans and angry critics. The critics were in the right, the partisans were at fault; but what does it matter now? Schleiden had again given a powerful impulse to the spirit of investigation, and that is the essential thing. His memoir, otherwise, is far from containing anything good or exact."

"Schleiden had disciples who were eager to adopt the doctrine of their master and promulgate it. At the same time, however, Mirbel and Brongniart skillfully guarded their opinions, and Meyen attempted a formal refutation of the new theory. A general and hot contest arose and lasted for more than twenty years, in which all the distinguished botanists of every country became engaged. Amici in 1842 confirmed and extended the previous observations of Mirbel, Spach, and Brongniart. He asserted that he had seen the embryo produced at the expense of a part of the embryonary sac, and this seemed to settle the question against Schleiden. Schleiden, however, hastened quickly to refute Amici's assertion. The great Modenese naturalist returned to the charge with his observations on the orchids. In 1850 the Academy of Amsterdam crowned a work of Schacht, a disciple of Schleiden's, who vigorously defended his master's theory. Tulasne, Hugo Mohl, Brongniart, Ch. Müller, and Hofmeister came forward to oppose it. It gave way and seemed to be dead; then it rose again and renewed the contest. On the 19th of December, 1854, Schacht triumphantly announced to the congress of naturalists, at Berlin, that a young man, Th. Deecke, a partisan, like himself, of Schleiden's doctrine, but more fortunate than he, had succeeded in making a microscopic preparation of *Pedicularis sylvatica* which was of such a nature as to reduce for ever to silence the adversaries of that theory. This preparation had a great repute. The story was passed around from city to city, but, while Schacht pretended that it was unanswerable, Hugo Mohl declared that he saw nothing conclusive in it. This was the last flickering of the theory of Schleiden. Radekofer published numerous observations against it in 1856, and announced at the same time that Schleiden had himself abandoned the theory which he had put forward. Shortly afterward, Schacht also acknowledged that he had been in error, and the theory, left dead on the battle-field, was buried for good."

With the vitality which Schleiden and his contemporaries had infused into botany a new era was inaugurated for the science. To mark its coming and extend the comprehension of the principles and aspirations of the new school, were needed a compendious and methodical treatise for students and a popular book for readers. Schleiden composed both. The time had passed when the study of living beings should form a separate branch of science, and when those who discarded the dry enumerations of the classifiers would have to fall into the ideal reveries of the "philosophers of nature." It needed to be shown that botany was not the mere dry skeleton which the former would make of it, and that it did not require the tinsel with which the latter assumed to adorn it. In the "Grundzüge der wissenschaftlichen Botanik" ("Elements of Scientific Botany") of Schleiden, the science was for the first time treated entirely according to the inductive method, as physics and chemistry had already been considered; and the different branches of science, till very recently still isolated and almost hostile, were made to interpenetrate and mutually illustrate each other. The book was well adapted to enlarge the scientific horizon, and to inspire youth and develop the spirit of research in them. The reading of the first few pages of the book is sufficient to give this impression of its motive. The dedication to Alexander von Humboldt, unquestionably the man of most universal knowledge of his time, attests the author's desire to connect botany intimately with the other sciences. The capital importance which he rightly attached to method is affirmed by the title which he gave to the second edition of his treatise—"Botany as an Inductive Science." The very first lines of his preface show that he does not intend to deal with a science of words and dreams, but of observation, experiment, and independent thought. "Whoever thinks he can learn botany in this book may as well put it aside at once without reading it, for botany can not be learned from books." In this work, says Dr. Karl Müller, Schleiden expressed for the first time a full comprehension that natural science was essentially a history of development, and expressed it in such a manner as to attract enthusiastic youth to his doctrine while he incurred the hostility of the elders in science. Among the salient features of his theory are the ascription of a leading part in all morphological questions to the study of the development of the organs, and his putting of the cryptogams upon a footing of equality in consideration with phanerogams. Perhaps no innovation in science has been so fruitful as the step which gave the prominent place in study to the first stages rather than to adult forms, to inferior beings rather than to elevated and complex groups.

One passage in the "Grundzüge" is worthy of especial remark, for the evidence it bears of the completeness of the author's rejection of the sterile categories of the older philosophers, and of his having been endowed with the scientific spirit of later times. "The division of natural objects into organic and inorganic could only have originated at a time when students had only the two extremes to consider. A person comparing a lion with a piece of chalk would, doubtless, say that the difference is evident to all the senses. But let him compare the small, almost spherical crystals of oxide of iron with the minute, spherical articulations of Ehrenberg's *Gallionella ferruginea*, which likewise consist almost exclusively of oxide of iron, and undeniably represent organic forms, either animal or vegetable: the crude antithesis disappears at once, and all who reflect will conceive for science the possibility, still distant, of bringing the formation of both kinds under the same law of nature. There are in nature thousands of these apparent leaps, like that from the inorganic to the organism, in regard to which attentive observation will reveal to us gradual differences instead of a specific distinction."

This work excited a wide-spread and virulent opposition in consequence of the bitterness of its polemics, its severe criticisms of the didactic methods of investigation and the dry systems in vogue at the time, and its sharp personalities. The book was called libelous in France, for the author, according to Dr. Karl Müller, seemed to speak well of no one except Robert Brown and Hugh Mohl, "the two living men whom he most admired," and was not sparing in his criticisms of them. "With incomparable acuteness, and with equal acerbity against living and dead, he poured out such a flood of botanical satires and personal antipathies that he would have had to be a god to escape the reaction against his attacks; and the day when this was to take place was not long in coming." Yet, he did not let his vehement criticisms go forth without making an excuse for them. It was that "enough merit still exists among true naturalists to permit us to leave the business of mutual admiration to the literary beggars of *belles-lettres* journalism." Notwithstanding this opposition, the current in favor of Schleiden's conception of the object of scientific study could not be diverted; and the medical faculty of Tübingen, one of whose members was Schleiden's most eminent opponent in a number of special cases, replied to his acrid charges by conferring upon him its honorary degree.

Schleiden's other book, "Die Pflanze und ihr Leben" ("The Plant and its Life"), the object of which was to popularize botany, had a brilliant success. The first edition of 1848 was rapidly followed by other editions, and the work appeared in the course of the next ten years in one French, one Dutch, and two English translations. The author, in the preface to this work, defines his object as follows: "Most people of the world, even the most enlightened, are still in the habit of regarding the botanist as a dealer in barbarous Latin names, as a man who gathers flowers, names them, dries them, and wraps them in paper, and all of whose wisdom consists in determining and classifying this hay which he has collected with such great pains. This portrait of the botanist was, alas! recently true; but, now that it is no longer applicable to the majority among us, I have been grieved to see that many still hold to it. So I have endeavored in these lectures to place within the reach of all the real principles of botanical science, and to show how it is intimately connected with all the leading problems of philosophy and the natural sciences." Beginning with an account of the structure of plants as revealed by the eye and the microscope, he recognizes the labors of Mohl, Nägeli, Payen, and others, and even has the courage to admit that they have damaged his own theory of the genesis of cells. The discussion of the nutritive elements of plants gives him occasion to do justice to Hales, De Saussure, Boussingault, and Liebig, his long-time adversary. Then, from applied botany, he passes to the two sciences which were quite new at the time, of botanical geography and paleontology ; and he concludes with a chapter in which the whole subject receives an æsthetical treatment.

Before this work appeared, however, Schleiden, discouraged by the success of the assaults upon his pet theories, had suffered a loss of confidence in himself and of relish for pure botany. His last work in pure science was a note on the fructification of the Rhizocarps, published in 1846 ; the "Zeitschrift für wissenschaftliche Botanik" ("Journal of Scientific Botany"), which he, with Nägeli, had founded in 1844, ceased to appear at the same time.

After completing the third edition of the "Grundzüge" in 1850, the failure to modify or improve which in any essential particular emphasizes his loss of relish for the pursuit, Schleiden withdrew almost entirely from the arena of scientific botany. He turned his attention to anthropology ; and, finally, in 1862, resigned his chair of botany at Jena, whence he repaired to Dresden. "Still, however, the old halo wavered around his head," and he was called to the University of Dorpat, as Professor of Botany and Anthropology, with the rank of a Russian councilor of state. He was not permitted to stay long there, however ; for, being accustomed to express himself too freely on ecclesiastical subjects in his public addresses, he soon raised a strong party against himself, and was obliged to resign his second professorship in 1864. From this time till the end of his life he resided by turns at Dresden, Frankfort-on-the-Main, Wiesbaden, and again at Frankfort, where he died on the 23d of June, 1881. Death surprised him while he was engaged upon a work on the horse, one of three monographs in which he designed to illustrate the influence of natural agents upon civilization, choosing as examples from each of the three kingdoms—salt, the rose, and the horse. The two of these treatises which we possess are models of their kind.

The character of Schleiden may be read in his writings. Ardent and enthusiastic, he never praised or blamed by halves ; but, in his most animated polemics, there appears a sincere and disinterested conviction that commands respect. To the end of his life he retained a degree of youthfulness in his thought and style. He had the imagination of a poet, with the scientific spirit to guide it ; and instead of being carried away, or letting his readers be carried away, in his flights, he is constantly calling them back to reality and reason. He erred in that he relied too much on his own deductions, and did not sufficiently appreciate the importance of verifying them by experiment and close observation. Thus it came about, as Karl Müller has remarked, that he has given us, in his works, "a diversified mixture of philosophical prepossession, jejune observation, and fanciful description. Nevertheless, despite his peculiar weaknesses, his followers recognize him as a reformer of botany, and allot him a permanent and eminent place in the history of that science."

Schleiden's works are numerous; we will mention "Grundzüge der wissenschaftlichen Botanik" (two vols., Leipsic, 1842–'43) ("Elements of Scientific Botany"), fourth edition 1861, translated into English by Dr. Lankester, London, 1849; "Die Pflanz und ihr Leben" ("The Plant and its Life"), sixth edition, Leipsic, 1864, translated by Professor Henfrey, London, 1848; "Handbuch der medicinisch pharmaceutischen Botanik" ("Manual of Medicinal Pharmaceutical Botany"), (Leipsic, 1852); "Studien" ("Studies"), (second edition 1857); "Handbuch der botanischen Pharmakognosie" ("Manual of Botanical Pharmacology"), (Leipsic, 1857); "Die Landenge von Suez" ("The Isthmus of Suez"), (1858); "Zur Theorie des Erkennens durch den Gesichtssinn" ("Additions to the Theory of Determination by the Sense of Sight"), (Leipsic, 1861); "Geognostische Beschreibung des Saalthals bei Jena" ("Geognostic Description of the Valley of the Saal at Jena"), (Leipsic, 1846); "Beiträge zur Botanik" ("Additions to Botany); "Pflanzen und Thierphysiologie in Encyklopädie der theoretischen Naturwissenschaft" ("Physiology of Plants and Animals in Encyclopædia for Theoretical Natural Philosophy"), (Braunschweig, 1850); "Gedichte" (pseudonym "Ernst"), ("Poems") (*nom de plume* "Ernst"), 1858; "Das Meer" ("The Ocean"), (Berlin, 1865); "Baum und Wald" ("Tree and Forest"), (1870); "Uber den Materialismus der neueren deutschen Naturwissenschaft" ("Materialism in Modern German Natural Philosophy"); "Die Bedeutung der Juden für die Erhaltung und Wiederbelebung der Wissenschaften im Mittelalter" ("The Signification of the Jews in the Conservation and Revival of the Sciences in the Middle Ages")—a work demonstrating the high degree of culture maintained by the Jews, even during the darkest periods of history, and the important part they had in the development of science and letters in Christendom—(1877); "Die Romantik des Martyriums bei den Juden im Mittelalter" ("The Romance of the Jewish Martyrology of the Middle Ages"), (Leipsic, 1878).

ENTERTAINING VARIETIES.

—— *Hindoo Ascetics.*—Hindostan is the native land of religious fanaticism. Burke ascribes it to the impressive grandeur of Nature (Himalayas, great rivers, East Indian tornadoes, etc.); Jacquemont, to subjective peculiarities of the East Aryan races; but the fact itself admits of no dispute: the Hindoos, as a nation, have always shown a remarkable tendency to sacrifice reason to faith, earth to heaven, and the welfare of the body to the fancied interests of the soul. The cave-temples of Ellora are said to have been excavated by volunteer armies of laborers; and, in a country where large hospitals full of eupeptic monkeys can be supported by voluntary contributions, such things are by no means impossible. During the yearly assemblies on the "God-field," at the junction of the Jumna and Ganges, many devotees sought a grave in the depths of the twice-holy flood, and Father Ricot, who witnessed one of these festivals, ascribes the extravaganzas of the pilgrims to the momentary inspiration of religious frenzy; but the achievements of the fakirs prove that even the modern Hindoos are capable of the most deliberate self-sacrifice. At the court of Baroda the spectators often leave the circus-games of the Guicowar to witness the stranger performances of a self-torturer, who, "for the edification of the pious," skewers, scorches, or mutilates himself in a way from which no mortal could recover. Nepaul, the border-land of Buddhism and Brahmanism, swarms with fakirs as Spain with begging friars. On the highway from Goorkha to Benares the traveler meets them at every cross-road. Some of them content themselves with sitting bare-headed in the open sun; others hang, head downward, from a bar, which they clasp with their hands and knees; others exhibit self-inflicted wounds, gashed faces, bared and splintered ribs, hands and feet bristling with tenpenny nails, as if they had undergone crucifixion. In the larger cities, where the public is used to such trifles, the more ambitious ascetics load themselves with wagon-chains, or bend their bodies in the form of a right angle, till the inflection of the spine becomes permanent. Nay, a not unfrequent "penance" consists in tying the hands to the ankles, and turning round and round like a cart-wheel. Near Goruckpoor the train of Lord Dalhousie met dozens of these animated monocycles, some of whom had rolled along for a distance of several hundred miles!

The Buddhists, with their superior talent for organization, have whole convents full of martyr-maniacs, who vie in the rigor and extravagant absurdity of their penances. Even novices forswear clothes in winter and cold water in summer, and sleep on gravel-piles. The sanctity of the presbyters is computed by the quantity of nauseous drugs they can swallow. Some of them emulate Dr. Tanner, and eat only once a day, and at certain seasons only once a week. Near Rangoon, at the mouth of the Irrawaddy, a society of penitents have located their convent in a pestilential swamp, and point with pride to their open windows, that admit every variety of troublesome insects. A thousand miles farther north the Thibetan monastery of Sookung braves the ice-storms of the eastern Himalayas at an elevation of fourteen thousand five hundred feet. The monks subsist on the charitable contributions of the neighboring towns, and are often in danger of freezing to death before they reach their castle in the clouds; but their home-life is said to be comparatively comfortable, especially in winter-time, when visitors are rare, for asceticism of the more persistent kind seems somehow to depend a good deal on public approbation. Simon Stylites had visitors from all parts of the Christian world, who admired and at last almost worshiped him. Besides sticking to his pillar, he had a trick of doubling himself up till his forehead almost touched his narrow pedestal. At evening prayers he often treated the spectators to a variety of Talmagian gymnastics, and, if they implored him to come down, his only answer was a grunt of stern defiance. In a lonely desert he probably would have anticipated their wishes. If there is anything meritorious in self-torture, the Indian fakirs, too, get all the encouragement they deserve. A Hindoo, who might dismiss an ordinary beggar with a kick, would share his last rice-cake with a mendicant presenting himself with a drag-chain round his neck and a bull-ring in his nose. The inventor of a new torture can count upon a liberal share of public patronage. The English garrison of Cawnpoor was once honored by the presence of a *bikschu*, or religious devotee, who had stationed himself in a corner of their parade-ground, and promoted the welfare of his soul by squatting down between two blazing fires, while the sun inflicted its caloric on his shaven head. A crowd of natives watched him with respectful admiration, and, whenever one of his fires threatened to go out, they fetched in a fresh supply of fuel, to further the progress of the good work.

The exploits of a sensational *bikschu* become the boast of his native place. Rass-el-Shork and Rass-el-Hissam, two suburbs of Delhi, had several riots about the respective merits of their fakirs. The matter was finally referred to a Mohammedan umpire, and the men of Hissam proved that their hero had passed forty-eight hours in tenter-hooks, and glorified Brahma by eating a three-pound bundle of wormwood, while the Shork party claimed the prize of virtue for a saint who had swallowed a gallon of cajeput-oil, and turned somersaults till the arithmetic of the suburb failed to express the number of thousands. He had also rolled himself from Delhi to Agra, fasted a full week, and abstained from drinking water while he counted the number of grains in a two-bushel measure of millet-seeds. But all his labors proved in vain when the umpire learned that the Hissam champion had once sat two days and a night in a nest-hill of the *Formica rufa* (a kind of red horse-ants).

Our word *fakir* is derived from the Arabian *fakhar*, a pauper, a mendicant. The Mohammedan dervishes, however, do not entirely part with their reason, though the Sufi sect believes in the sanctifying influence of celibacy and solitude. The Brahmans and Buddhists are both ultra-ascetic, but with this difference: that the former practice their penances as an expiation of some special sin; the others on general principles, and with a view of subduing the vitality of the body, for the world-blighting dogma of the antagonism of body and soul seems to have been first promulgated by Buddha Sakya-Muni, the Nepaul arch-pessimist.

—— In the columns of the "Catholic World" for August, the Rev. J. F. Callahan, D. D., discusses the "Cincinnati Pastoral" and its critics: "Liberty," says the Rev. J. F. C., D. D., "never did exist except under the shadow of the cross. Equality has no home except at the altar on which the shadow of that cross falls. Take the Catholic Church out of the world, and liberty would sink into an eternal grave. If Protestant nations are free, it is because they once were Catholics. If a republic was built in this New World, Catholic principles were the architect."

The absolute truth of the above rivals the candor of Dr. Christlieb's "Short Method with Infidels." Evidently the "persecuted classes," as the "Bavarian Brewers' Union" calls the Romanists and liquor-dealers, are learning the art of turning the tables against their aggressors. The next issue of the "B. B. U." will probably contain the following counterblast against the recent amendment of the Iowa Constitution: "Happiness never did exist except in an atmosphere of alcohol. Health has no home except at a fireside redolent with the smell of that atmosphere. Take distilleries out of the world, and manhood would sink into an eternal grave. Wherever a healthy constitution has been built up, alcoholic stimulants were the architect. If total abstainers are healthy, it is because their fathers were topers."

—— In "graphic descriptions" one touch of nature is worth a page of imaginary details: hence the realism of rustic poetry. The Ettrick Shepherd had passages of that sort that redeem all his barbarisms, and beat Goethe and Wordsworth at their own tricks. E. g., his description of a Lanarkshire snow-storm that cost the life of a Scotch Leander:

"But the snaw was so deep, and his heart it grew weary,
And he sank down to sleep on the moorland so dreary.
Oh, soft was the couch and embroidered the cover,
And white were the sheets she had spread for her lover;
But his couch is more white, and his canopy grander,
And sounder he sleeps *where the hill-foxes wander*."

—— "A false system with a fabulous historical record, and enforced by preposterously wrong methods," Diderot calls a certain anti-natural religion.

—— "Voltaire came before the Revolution like lightning before thunder."

"Experience is like a persistent coquette. Years pass before you can win her, and, if you finally may call her your own, you are both superannuated, and have no use for one another."

"The secret of every power consists in the knowledge that others are still greater cowards."

"Our time is not favorable to logic. So many candles need snuffing, that there is no chance for clear-seeing."

"All men love freedom. But the just demands it for all, the unjust for himself alone."—Ludwig Börne.

—— Some people seem born to be lucky in spite of themselves. General Skobeleff was originally destined for the bar, but before he was too old his pugnacious disposition caused his expulsion from college, and thus drove him into his right career, and by a series of equally well-timed scrapes at last into a field where he could follow his *penchant* with glory, as well as impunity. His pet project was a war against Prussia, and the timely accession of a Pan-Slavistic Czar enabled him to achieve popularity by a free expression of his anti-German sentiments. He became the idol of his nation, and died in time to escape the horrible thrashing that will follow the attempt to realize his favorite project.

—— There is nothing new under the sun; even our forestry associations had their prototypes in pagan Rome and Moorish Spain. Al Moctader, the Caliph of Bagdad (1094–1117), also planted millions of forest-trees; and it is a distressing fact that then, as now, many clear-sighted men foretold the consequences of reckless forest-destruction, and that their protests had no appreciable influence in checking the evil. The trouble seems to be that tree-felling is directly profitable and only eventually injurious, while tree-planting is directly expensive and only indirectly advantageous. Forest-destruction has ruined our earthly paradise, and the scientific authorities of all really enlightened nations have denounced it again and again; but, before such arguments can influence the masses, they must cease to seek their paradise in the clouds and their authorities in Palestine.

—— In the general diffusion of knowledge, only the newspaper-educated natives of our Northeastern cities can compare with the Saracens of the thirteenth century. Under her last caliphs, Cordova alone had fourteen lyceums and nine hundred and fifty primary schools; the transcription of the ancient classics employed an army of copyists, and the provincial governors vied in patronizing men of letters. From Leon to Granada every hamlet had its own library, and the lord of every castle a private cabinet of *curios* or an astronomical observatory. But during the next two centuries a horde of ecclesiastic Vandals marched in the wake of the Christian armies, and special commissioners of the Casa Santa traveled from place to place, burning Unitarians and destroying Arabian manuscripts.

What literary treasures may have perished in that way! The Spanish Moriscoes, the last free and manly nation of the Old World, succumbed to the hirelings of the Holy Inquisition; but Providence generally remedies a calamity of that sort, and the fall of Granada coincided with the discovery of a New World.

—— *A Maori Cosmogony.*—Richard Oberländer, in his "Strange Peoples," gives the following as a cosmogony of the New-Zealanders: Maui was a hero who performed as wonderful labors as the Grecian Heracles. He was not only the inventor of the arts of making boats and building houses and the like, but he appointed the paths of the sun and the moon, and was the creator of the earth, which he fished out of the sea in this way: He said one day to his five brothers, who were devoted fishermen, that he would go with them and catch so large a fish that they would not be able to hold him. Now, because they knew what an enchanter he was, and were afraid of his art, they were not willing to take him in the boat with them. Nevertheless, Maui went with them. He changed himself into a bird, flew into the canoe, and did not make himself known till they had got into the open sea. When they had got far out into the sea, Maui wanted to fish; he had a precious fish-hook with him, which he had made out of his grandfather's jaw-bone; but his brothers, to keep him from fishing, refused to give him any bait. Then Maui beat his face till his nose bled, and soaked some tow that he found in the canoe with the blood. That was the bait. Maui threw out his hook, and it was not long before he had a bite, with a tug that made the brothers afraid the boat would be upset. So they cried out, "Let go, Maui!" "Maui never lets go of what he holds," was the answer, and it has become a proverb with the Maoris. He pulled and pulled at the line till he pulled up a land. "*Ranga whenna!*" exclaimed the brothers, "the fish is a land!" Maui asked them if they knew the name of the fish, and, when they said no, he told them "*Haha whenna*" (the looked-for land.) After the fish was pulled up, the brothers hastened to divide it among themselves; they pulled and tore in every direction; hence come the inequalities of the island. The canoe was stranded by the rising of the land, and the Maoris say now that it lies on the top of Mount Ikaurangi, near the eastern cape of the island, where Maui is also buried. After this story, the northern island of New Zealand is called *Ahi na Maui* (the fish of Maui).

—— "They sow not, they reap not, they trust in Providence, and honor you by sharing the fruits of your worldly industry," is the gist of St. Francis of Assisi's argument in favor of the mendicant friars. The Hindoos are consistent enough to grant the same privileges to monkeys and crocodiles. In Lucknow there are two large monkey-hospitals, and several *mahakhunds*, where swarms of able-bodied Entellus-apes ("Honumans") and Rhesus baboons are fed at the expense of true believers. They get rice-pudding and sirup for dinner, while many hard-working but less sacred bipeds have to eat their rice "straight." But during the Sepoy rebellion the Mohammedan insurgents destroyed one of these establishments and expelled the inmates, including several venerable specimens of the white-headed Entellus, the holiest animal in the menagerie of the Hindoo Pantheon. For many weeks these long-tailed saints perambulated the streets in quest of cold lunch; and an eye-witness, Mrs. Allen Mackenzie, describes the indignation of the orthodox natives, who organized relief committees and monkey soup-houses, though the protracted siege had almost exhausted their own resources. To make matters worse, the streets swarmed with profane monkeys who had to forage for a living, and had no hesitation in black-mailing their sacred relatives. The Honumans had to submit to such outrages; nay, some of them learned to eat their rice-pudding without sirup, and probably consoled themselves with the hope of a better hereafter. They wandered from house to house, and in their great distress even accepted the assistance of unbelievers, but they absolutely refused to work.

—— *A Cheerful Summer Resort.*—On the hunting-grounds of the lower Lena, where the Fahrenheit thermometer often remains for weeks at 45° below zero, the Russian convicts are dressed in linen jackets, and wear *tretschki* (raw-hide shoes) without stockings. And yet they form the *élite* corps of the Siberian exiles—murderers, forgers, and highway robbers. Political offenders are sent to the mines of Berezov, where the average duration of life, or rather of slow death, is eight years and four months. The majority of the convicts die in less than five years. Minors work there from 6 A. M. till noon, and from 2 to 6 P. M.; adults from 6 A. M. to 6 P. M., *without intermission.* They have no Sunday, and only one holiday in the year, the birthday of the Czar. Their rations are those of a private soldier, viz., rye-bread and salt beef. After dark they are confined in log-pens, and have to pass the nights of the long Siberian winter between two army-blankets, the one covering the rough-hewed logs of the floor, the other their starved bodies, wrapped in the coarse linen uniform which they are permitted to change only once a month. Chimney-fires are allowed during the supper-hour, i. e., from 6 to 7 P. M., but the majority swallow their food in the dark, and devote the short interval of light and warmth to—entomological researches. The discipline is that of a dog-kennel—kicks and cudgel-blows—and malingering is discouraged by a simple and effective method: the sick (wounded excepted) are put on quarter-rations. Attempts at flight are less frequent than riots, for recaptured fugitives were knouted; mutineers are only shot.

Human beings can get used to worse things than Siberian rye-bread, but never to Siberian frosts, and the monthly fuel rations of the Berezov convicts are limited to one *starsnik* (about half a cord) per cabin, though near the mines of the western slope the same mountain-range abounds with densely timbered districts. In an interview with the commander of Berezov, a correspondent of the "Cologne Gazette" suggested the propriety of removing the settlement to the timber-region. "It would probably please the prisoners," replied the commander, but the comfort of their keepers was of more consequence, and all his subalterns agreed that, on account of the trout-streams and cranberry-brakes of the eastern slope, Berezov was a more pleasant summer resort.

EDITOR'S TABLE.

SPENCER'S IMPRESSIONS OF AMERICA.

THERE was a strong and perhaps a quite laudable curiosity on the part of many pople to know what impression had been made upon the mind of Herbert Spencer when first coming to this country. It was certainly something more than an idle curiosity on the part of a large number of our citizens to learn his impressions, because it was widely kown that he is a philosophical student of national institutions, and probably the highest living authority on the science of human society. He has been very widely read and much studied in this country, and it was felt that his views, whether favorable or not, would certainly be interesting, and his criticisms, if he made any, suggestive and valuable.

And it was no doubt because of his respect for this sincere desire, to get at his real views, that Mr. Spencer persistently declined to be hastily and prematurely interviewed by the professionals of the press, whose ways of doing such things are not always favorable to the representation of important truths. What they generally most want is frivolous gossip and personal particulars, to be dressed up for sensational purposes, and to be had exclusively for the benefit of enterprising newspapers. Mr. Spencer was indeed repeatedly applied to by reporters of a better character who would have represented him in his own way, and with fullness and fairness, but the state of his health long made it impossible that he could consent to be questioned.

And there was certainly plenty of reason why he should be in no hurry to venture upon an expression of opinion regarding American social and political affairs. It was easy enough to say how he was struck by the external aspects of American life, but it was not so easy to get familiar with the working of the internal elements and forces of our social and political life. It was easy enough to compare our cities, steamboats, railroads, rural scenery, and open habits of the people with those of the olden countries, but a very different thing to form an intelligent judgment of the operation of complex institutions and the slow-working social tendencies in a nation that covers a continent. Perhaps no living man is so well aware of the magnitude and the difficulties of the problems now being worked out by the people of these associated States as Mr. Spencer, and he could not but feel that a two months' sojourn among us in a very unfavorable state of health was but a very insufficient preparation for an intelligent verdict upon American social and political problems. Yet his previous occupation with such subjects certainly qualified him to form opinions of what he saw and heard and at the proper time he had no hesitation in expressing them.

And that he was prepared to speak a good deal to the point, to offer views of moment, and suggest weighty criticisms, has been sufficiently proved by the way his opinions have been received in all quarters. They have been very extensively published from the Atlantic to the Pacific, and as extensively commented upon. No such message from any foreigner has ever compelled equal attention, or been received in a better spirit. There has been very wide agreement with Mr. Spencer's most important statements, and, where assent has been denied, it has still been recognized that the questions raised are fundamental, and that Mr. Spencer has done us an eminent service in setting people to thinking about the sources of danger to our institutions, and the duties of citizens in regard to them.

In one respect the time of publication was somewhat unfortunate. The results of the interview were offered to the New York press to all the New York newspapers at the same time and without previous notice, and, as the columns of the press are generally much crowded in an active political campaign, there was some difficulty in publishing the communication. Several papers felt it necessary to shorten it by omitting what they regarded as the less important parts, so that imperfect representations of the interview were extensively circulated and republished. This being known, there has been a good deal of call for the document in its complete form, which could not be met. We have accordingly thought it best to reprint the interview in full. It will certainly not be news to our readers, but it may be well to have a permanent record of it for future reference:

Hearing that HERBERT SPENCER had returned to New York in a somewhat improved condition of health, an intimate American friend obtained his consent to be questioned regarding his impressions of this country to the following effect:

I believe, Mr. Spencer, that you have not been interviewed since your arrival in this country?

I have not. The statements in the newspapers implying personal intercourse are unauthorized, and many of them incorrect. It was said, for example, that I was ill from the effects of the voyage; the truth being that I suffered no inconvenience whatever, save that arising from disturbed rest. Subsequent accounts of me in respect of disorders, diet, dress, habits, etc., have been equally wide of the mark.

Have these misrepresentations been annoying to you?

In some measure, though I am not very sensitive; but I have been chiefly annoyed by statements which affect, not myself only, but others. For some ten days or more there went on reappearing in various journals, an alleged opinion of mine concerning Mr. Oscar Wilde. The statement that I had uttered it was absolutely baseless. I have expressed no opinion whatever concerning Mr. Oscar Wilde. Naturally, those who put in circulation fictions of this kind, may be expected to mix much fiction with what fact they report.

Might not this misrepresentation have been avoided by admitting interviewers?

Possibly; but, in the first place, I have not been sufficiently well; and, in the second place, I am averse to the system. To have to submit to cross-examination, under penalty of having ill-natured things said if one refuses, is an invasion of personal liberty which I dislike. Moreover, there is implied what seems to me an undue love of personalities. Your journals recall a witticism of the poet Heine, who said that "when a woman writes a novel, she has one eye on the paper and the other on some man—except the Countess Hahn-hahn, who has only one eye." In like manner, it seems to me that in the political discussions that fill your papers, everything is treated in connection with the doings of individuals—some candidate for office, or some "boss" or wire-puller. I think it not improbable that this appetite for personalities, among other evils, generates this recklessness of statement. The appetite must be ministered to; and in the eagerness to satisfy its cravings, there comes less and less care respecting the correctness of what is said.

Has what you have seen answered your expectations?

It has far exceeded them. Such books about America as I had looked into, had given me no adequate idea of the immense developments of material civilization which I have everywhere found. The extent, wealth, and magnificence of your cities, and especially the splendor of New York, have altogether astonished me. Though I have not visited the wonder of the West, Chicago, yet some of your minor modern places, such as Cleveland, have sufficiently amazed me, by the marvelous results of one generation's activity. Occasionally, when I have been in places of some ten thousand inhabitants, where the telephone is in general use, I have felt somewhat ashamed of our own unenterprising towns; many of which, of fifty thousand inhabitants and more, make no use of it.

I suppose you recognize in these results the great benefit of free institutions?

Ah, now comes one of the inconveniences of interviewing. I have been in the country less than two months; have seen but a relatively small part of it, and but comparatively few people; and yet you wish from me a definite opinion on a difficult question.

Perhaps you will answer, subject to the qualification that you are but giving your first impressions?

Well, with that understanding, I may reply that, though free institutions have been partly the cause, I think they have not been the chief cause. In the first place, the American people have come into possession of an unparalleled fortune—the mineral wealth, and the vast tracts of virgin soil producing abundantly with small cost of culture. Manifestly that alone goes a long way toward producing this enormous prosperity. Then they have profited by inheriting all the arts, appliances, methods, developed by older societies, while leaving behind the obstructions existing in them. They have been able to pick and choose from the products of all past experience; appropriating the good and rejecting the bad. Then, besides these favors of fortune, there are factors proper to themselves. I perceive in American faces generally, a great amount of determination—a kind of "do or die" expression; and this trait of character, joined with a power of work exceeding that of any other people, of course produces an unparalleled rapidity of progress. Once more, there is the inventiveness, which, stimulated by the need for economizing labor, has been so wisely fostered. Among us in England, there are many foolish people who, while thinking that a man who toils with his hands has an equitable claim to the product, and, if he has special skill, may rightly have the advantage of it, also hold that if a man toils with his brain, perhaps for years, and, uniting genius with perseverance, evolves some valuable invention, the public may rightly claim the benefit. The Americans have been more far-seeing. The enormous museum of patents which I saw at Washington, is significant of the attention paid to inventors' claims; and the nation profits immensely from having, in this direction (though not in all others), recognized property in mental products. Beyond question, in respect of mechanical appliances, the Americans are ahead of all nations. If, along with your material progress, there went equal progress of a higher kind, there would remain nothing to be wished.

That is an ambiguous qualification. What do you mean by it?

You will understand when I tell you what I was thinking of the other day. After pondering over what I have seen of your vast manufacturing and trading establishments, the rush of traffic in your street-cars and elevated railways, your gigantic hotels and Fifth Avenue palaces, I was suddenly reminded of the Italian republics of the middle ages; and recalled the fact that, while there was growing up in them great commercial activity, a development of the arts which made them the envy of Europe, and a building of princely mansions which continue to be the admiration of travelers, their people were gradually losing their freedom.

Do you mean this as a suggestion that we are doing the like?

It seems to me that you are. You retain the forms of freedom, but, so far as I can gather, there has been a considerable loss of the substance. It is true that those who rule you do not do it by means of retainers armed with swords; but they do it through regiments of men armed with voting-papers, who obey the word of command as loyally as did the dependants of the old feudal nobles, and who thus enable their leaders to override the general will and make the community submit to their exactions as effectually as their prototypes of old. It is doubtless true that each of your citizens votes for the candidate he chooses for this or that office, from President downward, but his hand is guided by a power behind, which leaves him scarcely any choice. "Use your political power as we tell you, or else throw it away," is the alternative offered to the citizen. The political machinery as it is now worked has little resemblance to that contemplated at the outset of your political life. Manifestly, those who framed your constitution never dreamed that twenty thousand citizens would go to the poll led by a "boss." America exemplifies, at the other end of the social scale, a change analogous to that which has taken place under sundry despotisms. You know that in Japan, before the recent revolution, the divine ruler, the Mikado, nominally supreme, was practically a puppet in the hands of his chief minister, the Shogun. Here it seems to me that the "sovereign people" is fast becoming a puppet which moves and speaks as wire-pullers determine.

Then you think that republican institutions are a failure?

By no means! I imply no such conclusion. Thirty years ago, when often discussing polities with an English friend, and defending republican institutions, as I always have done and do still; and when he urged against me the ill-working of such institutions over here; I habitually replied that the Americans got their form of government by a happy accident, not by normal progress, and that they would have to go back before they could go forward. What has since happened seems to me to have justified that view; and what I see now confirms me in it. America is showing on a larger scale than ever before, that "paper constitutions" will not work as they are intended to work. The truth, first recognized by Mackintosh, that "constitutions are not made, but grow," which is part of the larger truth that societies throughout their whole organizations are not made but grow, at once, when accepted, disposes of the notion that you can work, as you hope, any artificially-devised system of government. It becomes an inference that if your political structure has been manufactured, and not grown, it will forthwith begin to grow into something different from that intended—something in harmony with the natures of citizens and the conditions under which the society exists. And it evidently has been so with you. Within the forms of your constitution there has grown up this organization of professional politicians, altogether uncontemplated at the outset, which has become in large measure the ruling power.

But will not education and the diffusion of political knowledge fit men for free institutions?

No. It is essentially a question of character, and only in a secondary degree a question of knowledge. But for the universal delusion about education as a panacea for political evils, this would have been made sufficiently clear by the evidence daily disclosed in your papers. Are not the men who officer and control your Federal, State, and municipal organizations—who manipulate your caucuses and conventions, and run your partisan campaigns—all educated men? and has their education prevented them from engaging in, or permitting, or condoning, the briberies, lobbyings, and other corrupt methods which vitiate the actions of your administrations? Perhaps party newspapers exaggerate these things; but what am I to make of the testimony of your civil-service reformers—men of all parties? If I understand the matter aright, they are attacking, as vicious and dangerous, a system which has grown up under the natural spontaneous working of your free institutions—are exposing vices which education has proved powerless to prevent.

Of course, ambitious and unscrupulous men will secure the offices, and education will aid them in their selfish purposes; but would not those purposes be thwarted, and better government secured, by raising the standard of knowledge among the people at large?

Very little. The current theory is that if the young are taught what is right, and the reasons why it is right, they will do what is right when they grow up. But, considering what religious teachers have been doing these two thousand years, it seems to me that all history is against the conclusion, as much as is the conduct of these well-educated citizens I have referred to; and I do not see why you expect better results among the masses. Personal interests will sway the men in the ranks as they sway the men above them; and the education which fails to make the last consult public good rather than private good, will fail to make the first do it. The benefits of political purity are so general and remote, and the profit to each individual so inconspicuous, that the common citizen, educate him as you like, will habitually occupy himself with his personal affairs, and hold it not worth his while to fight against each abuse as soon as it appears. Not lack of information, but lack of certain moral sentiments, is the root of the evil.

You mean that people have not a sufficient sense of public duty?

Well, that is one way of putting it; but there is a more specific way. Probably it will surprise you if I say that the American has not, I think, a sufficiently quick sense of his own claims, and at the same time, as a necessary consequence, not a sufficiently quick sense of the claims of others—for the two traits are organically related. I observe that you tolerate various small interferences and dictations which Englishmen are prone to resist. I am told that the English are remarked on for their tendency to grumble in such cases; and I have no doubt it is true.

Do you think it worth while for people to make themselves disagreeable by resenting every trifling aggression? We Americans think it involves too much loss of time and temper, and doesn't pay.

Exactly. That is what I mean by character. It is this easy-going readiness to permit small trespasses because it would be troublesome or profitless or unpopular to oppose, which leads to the habit of acquiescence in wrong, and the decay of free institutions. Free institutions can be maintained only by citizens each of whom is instant to oppose every illegitimate act, every assumption of supremacy, every official excess of power, however trivial it may seem. As Hamlet says, there is such a thing as greatly to find quarrel in a straw, where that straw implies a principle. If, as you say of the American, he pauses to consider whether he can afford the time and trouble—"whether it will pay"—corruption is sure to creep in. All these lapses from higher to lower forms begin in trifling ways; and it is only by incessant watchfulness that they can be prevented. As one of your early statesmen said, "The price of liberty is eternal vigilance." But it is far less against foreign aggressions upon national liberty, that this vigilance is required, than against the insidious growth of domestic interferences with personal liberty. In some private administrations which I have been concerned with, I have often insisted, much to the disgust of officials, that instead of assuming, as people usually do, that things are going right until it is proved that they are going wrong, the proper course is to assume that they are going wrong until it is proved that they are going right. You will find, continually, that private corporations, such as joint-stock banking companies, come to grief from not acting upon this principle. And what holds of these small and simple private administrations, holds still more of the great and complex public administrations. People are taught, and, I suppose, believe, that "the heart of man is deceitful above all things and desperately wicked"; and yet, strangely enough, believing this, they place implicit trust in those they appoint to this or that function. I do not think so ill of human nature; but, on the other hand, I do not think so well of human nature as to believe it will do without being watched.

You hinted that while Americans do not assert their own individualities sufficiently in small matters, they, reciprocally, do not sufficiently respect the individualities of others.

Did I? Here, then, comes another of the inconveniences of interviewing. I should have kept this opinion to myself if you had asked me no questions; and now I must either say what I do not think, which I can not, or I must refuse to answer, which perhaps will be taken to mean more than I intend, or I must specify, at the risk of giving offense. As the least evil I suppose I must do the last. The trait I refer to comes out in various ways, small and great. It is shown by the disrespectful manner in which individuals are dealt with in your journals—the placarding of public men in sensational headings, the dragging of private people and their affairs into print. There seems to be a notion that the public have a right to intrude on private life as far as they like; and this I take to be a kind of moral trespassing. It is true that during the last few years we have been discredited in London by certain weekly papers which do the like (except in the typographical display); but in our daily press, metropolitan and provincial, there is nothing of the kind. Then, in a larger way, the trait is seen in this damaging of private property by your elevated railways without making compensation; and it is again seen in the doings of railway governments, not only when overriding the rights of shareholders, but in dominating over courts of justice and State governments. The fact is, that free institutions can be properly worked only by men each of whom is jealous of his own rights, and also sympathetically jealous of the rights of others—will neither himself aggress on his neighbors, in small things or great, nor tolerate aggression on them by others. The republican form of government is the highest form of government; but because of this it requires the highest type of human nature—a type nowhere at present existing. We have not grown up to it, nor have you.

But we thought, Mr. Spencer, you were in favor of free government in the sense of relaxed restraints, and letting men and things very much alone—or what is called *laissez faire?*

That is a persistent misunderstanding of my opponents. Everywhere, along with the reprobation of government-intrusion into various spheres where private activities should be left to themselves, I have contended that in its special sphere, the maintenance of equitable relations among citizens, governmental action should be extended and elaborated.

To return to your various criticisms, must I then understand that you think unfavorably of our future?

No one can form anything more than vague and general conclusions respecting your future. The factors are too numerous, too vast, too far beyond measure in their quantities and intensities. The world has never before seen social phenomena at all comparable with those presented in the United States. A society spreading over enormous tracts while still preserving its political continuity, is a new thing. This progressive incorporation of vast bodies of immigrants of various bloods has never occurred on such a scale before. Large empires composed of different peoples, have, in previous cases, been formed by conquest and annexation. Then your immense plexus of railways and telegraphs tends to consolidate this vast aggregate of States in a way that no such aggregate has ever before been consolidated. And there are many minor co-operating causes unlike those hitherto known. No one can say how it is all going to work out. That there will come hereafter troubles of various kinds, and very grave ones, seems highly probable; but all nations have had, and will have, their troubles. Already you have triumphed over one great trouble, and may reasonably hope to triumph over others. It may, I think, be reasonably held that both because of its size and the heterogeneity of its components, the American nation will be a long time in evolving its ultimate form; but that its ultimate form will be high. One great result is, I think, tolerably clear. From biological truths it is to be inferred that the eventual mixture of the allied varieties of the Aryan race forming the population, will produce a more powerful type of man than has hitherto existed, and a type of man more plastic, more adaptable, more capable of undergoing the modifications needful for complete social life. I think that whatever difficulties they may have to surmount, and whatever tribulations they may have to pass through, the Americans may reasonably look forward to a time when they will have produced a civilization grander than any the world has known.

PRINCIPLE IN SMALL THINGS.

No part of the foregoing deliverance is more true than that which refers to American tolerance of interference and dictation in the lesser affairs of life. What people do, habitually illustrates character, and American character in this important respect is undoubtedly of a low type. The forms of free institutions have not engendered the sentiment of personal independence which resents encroachments and insists upon justice. The institutions are nominally free, but the citizens who grow up under them are not free in the sense of exemption from impertinent meddlings and petty tyranny.

There is wanting the spirit of resistance to apparently trivial violations of right. The man who would fight for his country will not fight a despotic neighbor, but will tamely acquiesce in wrong for the sake of peace and neighborly harmony. This spirit of complacent acquiescence in wrongs inevitably breeds wrong-doers to take advantage of it. Where there is a low regard for the strictly equitable, equity is sure to be violated. There are always natures that will encroach if not resisted, because the roots of aggression run deep in the soil of selfishness. Boys of strong wills that are petted and pampered, or left unrestrained at home, become bullies in the streets and tyrants in their social relations. "Resistance to tyrants is obedience to God," of course, but that means the *foreign* tyrant, not the one next door, or in the school-board, or church, or in the car, or restaurant — to resist him might make unpleasant disturbance. Habitual submission to inflicted wrongs, however small, is simply moral cowardice, and there is no disguising the fact that it is a very large element of the American character. Mr. Spencer has diagnosed our condition in this respect from a very few symptoms, but the illustrations of wrong tolerated from timidity and dread of what people will say, if small aggressions are seriously resisted, are all too plentiful. An excellent example of it occurred recently, which it is worth while to note.

Bicycles upon the sidewalks, as everybody knows, are not particularly conducive to the comfort of pedestrians. Even the small machines impelled by children, though hardly dangerous, are often annoying. But large bicycles, ridden rapidly by strong boys on the sidewalk, are sources of constant solicitude to those who are walking, are dangerous, often result in accidents, and are simply nuisances that should not be tolerated. In most English villages, as we are informed, bicycles are not allowed on the sidewalks; and the hand-books issued by English manufacturers of bicycles caution their customers that it is a forbidden practice, while in many places bells have to be attached to the bicycles even when ridden in the streets. To what degree this practice is general here in country towns we do not know, but there has recently been an experience in this matter in the village of Stockbridge, Massachusetts, which is quite American in its way.

In the first place, Stockbridge is a charming town among the Berkshire hills, much resorted to as a summer residence by city people. Moreover, the people that go there and the people that live there are eminently cultivated and refined; wealth abounds, and it is not a place where poor people are much harbored. In education, intelligence, and all the moral qualities which are said to accompany mental cultivation, Stockbridge is an American village of a superior sort. It will be long, very long before American villages generally come up to the Stockbridge standard of culture and good-breeding.

Nevertheless, all grades of bicycles were allowed upon the Stockbridge sidewalks, and the vexation and danger attending the practice were such, that last July one of the summer residents presented a petition, signed by eighteen prominent residents, to the board of selectmen, praying that the use of bicycles on the sidewalks be prohibited. Immediately after a remonstrance signed by thirty residents was got up and handed to the selectmen. Understanding that the main objection to the original petition was that it did not discriminate between large and small bicycles, the gentlemen who drew the first document prepared a second draft, asking only that *large* bicycles should be excluded from the sidewalks of the village, and this was signed by one hundred and sixty-eight residents.

Many who had signed the remonstrance now signed the petition, so that the consent of the village to the measure proposed was regarded as practically unanimous.

But there was an active party in favor of the boys, who were determined that they should not be interfered with in their amusement, and so the selectmen played into the hands of this party by excluding all bicycles, *large and small*, from the sidewalks, well knowing that this step would cause such irritation as to defeat itself. The consequence was that the order of exclusion was rescinded, and all bicycles, large and small, were once more allowed to run freely on the sidewalks, except in the small portion of the village occupied by the stores, hotel, and bank.

The gentleman, a distinguished professor of Columbia College, who moved in the matter, attempted to arouse public sentiment upon the subject, and, as there was no newspaper printed in the village, he posted up a handbill with a list of thirteen accidents, and cases of serious annoyance, that had occurred; and shortly after posted up ten additional cases, signed with his well-known initials, to show by facts that the practice resisted was really a dangerous one. These posters were removed by the selectmen. He then printed a letter, stating the case fully, and giving an account of twenty accidents, and placed a copy in every box in the village post-office, addressed to the chief residents. One was also sent to the editor of the "Springfield Republican," who made a notice of it, and one hundred copies of his paper were distributed in the village, all of which failed to produce any effect.

Now, our interest in this matter is purely scientific. We take the data, find their explanation, and draw conclusions respecting the true grade of Stockbridge society.

The facts in a sentence are simply these: Half a dozen boys, in the pursuit of a selfish gratification, persist in violating the rights of citizens, and this conduct is sustained by the community which yet acknowledges the outrage.

And how is it to be explained? By the indifference of the people to the subject as a matter of right and wrong; or a laxity of moral sense. The gentleman who moved in the matter, and should have been regarded as a public benefactor, was not supported, but was condemned for his action. Of course, when such an issue was once raised, there was tenfold necessity to put down the openly immoral party; but the raising of the issue only cowed their opponents, and disclosed the absence of moral backbone in the Stockbridge character. "It was really such a petty matter, such small business, to be meddling with the enjoyments of the dear boys!"—from which we get an idea of the quality of Stockbridge ethics, which is far too much the American sort. Small trespasses are to be tolerated, and only outrages that comport with the scale of American ideas are to be reprobated. Abuses that have in them something of the breadth of the continent or the length of the Mississippi, or the bigness of the national debt, are worthy to excite indignation; but mere sidewalk offenses—nonsense!

It is to be presumed, of course, that Stockbridge education conforms to the standard of its public opinion. The boys are sent to school, and taught book-lessons in morality, including sensitiveness to the rightful claims of others, and especially solicitude for the weak and helpless, and then they take lessons in the out-of-door practical morality of running over baby-carriages, upsetting old people, and disturbing everybody, because the sidewalk is a little nicer than the street for bicycle riding.

From all of which we may fairly infer the grade of Stockbridge civilization. Its people may be refined and educated, affluent, polished, and devotional; but they are, nevertheless, barbarians: for the degree of barbarism in any community is measured by the impunity with which its members seek their gratification at each other's expense.

LITERARY NOTICES.

George Ripley. By Octavius Brooks Frothingham. Boston: Houghton, Mifflin & Co. Pp. 321. Price, $1.50.

Mr. Frothingham's life of Ripley is a very pleasant and entertaining, if not in the highest degree instructive, book upon its subject. As a biographer, in this case he has the advantage of having been long and intimately acquainted with the man whose life he delineates, of having a similar culture and a broad sympathy with his aims. But while these qualifications are favorable to the appreciation of Mr. Ripley's character, they are not so favorable to that criticism of it which is perhaps necessary to extract the highest lesson from its career. Mr. Frothingham has given us a model biography from a literary point of view, but we suspect that in future the work of describing men's lives must more and more pass into the hands of those who have a scientific preparation for the work. We must have something more than the mere narration of a career in a fine literary form; we must have analysis and a critical judgment of character in relation to the circumstances in which it was displayed.

Mr. Ripley's life was divided into several stages. He was a bright, clear-headed boy of unusual capacity, fond of books, and learning from them with great facility. He accepted the customary course of study, and went through college early and with distinction. He was absorbed in classical studies, and paid very little attention to science of any kind. His culture was therefore one-sided, and he was in consequence to no small degree the victim to his university education.

From college he passed into professional life, taking the line of divinity. In preparation for this he had crammed German metaphysics to an inordinate degree, and brought a large theological erudition to his pulpit labors. He worked zealously and most conscientiously in this field for upward of a dozen years, and, being dissatisfied with the result, decided to abandon it. We are of opinion that with his strong common sense, if he had any fair share of scientific cultivation, he would either have kept out of the clerical profession or would have succeeded in it by subordinating theology to truth and making an independent career. He had abundant talent for this purpose. But, as it was, his theology broke down and he left it.

Mr. Ripley then entered upon the third stage of his career, which was both very natural and not a little remarkable. Earnestly desiring to realize a nobler ideal of life than is fulfilled by the present state of society, even under a religious organization which he had faithfully tried, he resolved to embark in a new social project that promised to yield higher satisfactions than are derived from the existing state of society.

He joined the association at Brook Farm, now a curiosity of history, and resolved to devote himself to the practical realization of a more harmonious social life by an experimental trial of what is possible in this direction. He had eminent coadjutors, who were animated by the same high aspirations, but Ripley was the life and soul of the movement. Never, perhaps, was before gathered a more sincere and unselfish band of devotees than those who made the attempt to carry out a reconstructive social reform at Brook Farm. The experiment failed, of course, and Ripley was left saddled with its debts, all of which he afterward most honorably discharged.

We say Brook Farm failed "of course," and this for the very simple reason that ideal states of society implying natures of a high grade can not be suddenly manufactured out of materials long shaped and adapted to a lower social condition. The adventurers of Brook Farm were sentimentalists, enthusiasts, and philanthropists, amiable and earnest, but of the literary type which implies a highly cultivated ignorance of all the natural laws by which terrestrial affairs are governed. If George Ripley had studied natural things when in college for half the time, and got some tolerable idea of the limitations of human nature under inexorable natural ordinances, he would not have plunged into so crude and futile an experiment as that at Brook Farm. Of course, it was a generous and noble, an heroic and a chivalric endeavor, and creditable to the hearts of those who turned their backs upon a selfish and sordid civilization to achieve a more harmonious and elevated life; but it was discreditable to their heads that they had not the intelligence to know that it *must* end just where it *did* end—in hopeless failure. Brook Farm collapsed because it was a project of impracticables whose education had been classical instead of scientific.

With the failure of Brook Farm Mr. Ripley took to the vocation of literature. Tired of making the world over, he resolved to accept it as it is, and make the most of it. His success was small at first, but he was an excellent critic, a fine writer, and an indefatigable worker, and these qualities were sure to win success. His career as a journalist and editor is fully and admirably described by Mr. Frothingham, and is very interesting; but it would be easy to show that the lack of the scientific element in his culture was as much a drawback in his later labors as in those that preceded them.

The New Botany. A Lecture on the Best Method of teaching the Science. By W. J. Beal, M. Sc., Ph. D. Second edition, revised. Philadelphia: C. H. Marot. 1882. Pp. 16. Price, 25 cents.

There is no class of persons who need teaching more than teachers. There are a few born educators whose native instinct, if not perverted by bad teaching, prompts them to pursue natural and rational methods for teaching others, but the average teacher teaches as he himself was taught, so that bad methods are propagated and spread indefinitely. The author of the pamphlet before us draws an interesting and life-like picture of the old way of teaching botany, in which the sole end and aim was to memorize the parts of the plant, and then learn its name by the aid of an artificial key, thus obtaining a most formal introduction to the stranger.

The new botany began to appear in this country in 1862, and includes a study of the subjects as set forth by Darwin, Sachs, Lubbock, Bessey, and others. It studies objects before books, and sets the pupil to thinking, investigating, and experimenting for himself. Teaching the new botany properly "is simply giving the thirsty a chance to drink." It also creates a thirst which the study gratifies, but never entirely satisfies. For young pupils object-lessons are very popular for a while, but in most cases the interest soon wears away; there is too much pouring in, and too little worked out by the pupil. They bring forth the combined information of all members of a class, but add little or nothing by way of research. To be really appreciated, a student should earn his facts in the study of biology. The author says: "In the whole course in botany I keep constantly in view how best to prepare students to acquire information for themselves with readiness and accuracy. This is a training for power, and is of far more value than the mere information acquired during a course of study in natural science."

The difficulty in the way of teaching the new botany is a serious, almost a fatal one, namely, it requires *an actual knowledge* of the subject on the part of the teacher; it can not be taught, like history and geography, by text-books; and, in addition, the teacher must have tact as well as knowledge. We have not yet reached the millennium of education, when each science shall be taught only by its true disciples and investigators.

Is Consumption contagious? And can it be transmitted by Means of Food? By Herbert C. Clapp, A. M., M. D. Second edition. Boston: Otis Clapp & Son. 1882. Pp. 187. Price, 75 cents.

That a second edition of such a book should be called for within two years after its first appearance is sufficient proof of the interest felt in the subject by the people as well as the profession. The author does not set out to prove that consumption is contagious, but presents the arguments advanced on both sides, with such an array of cases that the reader feels almost convinced that it must be either infectious or contagious. Koch's discovery, which has been made since the first edition, is referred to in the new preface and described in the appendix. That this discovery has an important bearing on the question propounded by Dr. Clapp is evident, and in general is strongly favorable to an affirmative answer. We need not here enumerate the various other reasons presented on this side of the question, such as the immunity of barbarous races from phthisis until they begin to be associated with the whites, its prevalence in convents, harems, and barracks, the frequency of the disease in wives who have nursed tuberculous husbands, etc. Whether the reader admits that the case is proved, the dictates of reason favor the observance of certain precautions, such as not allowing the same person to remain in too constant attendance on consumptives, nor permitting another to sleep with them, securing the most perfect ventilation possible, and the exercise of great cleanliness with immediate removal and destruction of sputa.

The remainder of the book is devoted to a discussion of the effect of tuberculous food, a subject of no less practical importance than the former. The occurrence of tuberculosis among cows and oxen being quite frequent, it is important that every possible means be employed to prevent the consumption of such beef by human beings. Milk from cows affected by this disease is even more to be feared, owing to the difficulty of preventing its sale, and the fact that the greater part of it is consumed without cooking. In addition to this we must consider that milk frequently forms the entire food of young children, and is an important article of diet with invalids, both of whom are more liable to attacks of any new disease than are older and more healthy persons. Aside from the dangerous infective properties, such milk is objectionable as an article of food, owing to its deficiency in fat, sugar, and the nitrogenous elements. The only remedy against these dangers from beef and milk is to be found in a careful, *honest* governmental inspection of all the meat that comes into our markets, especially at the slaughter-houses, and of the cows that furnish our milk, with particular reference to the existence of this disease. It may be a difficult and expensive undertaking, but, for our safety, it must be done.

The book, on the whole, is not intended to quiet the fears of nervous people, or to convince the timid that there is little to be feared from the dreaded scourge—consumption.

The Sun. By Professor C. A. Young. New edition.

We are glad to see a new and carefully revised edition of this admirable and standard work, and also that successive editions are called for abroad. Great pains have been taken by the author to give the highest accuracy to the text, and he has appended, in the form of notes, all the new and important information that has accumulated since the first issue. None of these additions discredit what may be regarded as established facts and principles relating to the sun, but they constitute interesting extensions of solar knowledge, together with new and ingenious speculations, the value of which time alone can determine. Professor Young has done well in thus keeping his book sharply up to the time, by which it will maintain its leading position in astronomical literature.

La Navigation Électrique (Electric Navigation). By Georges Dary. Paris: J. Baudry. Pp. 65, with 17 Illustrations in the text.

The first part of this work gives the history of the attempts to apply electrical force to the propulsion of boats and air-ships, including the first essay by M. de Jacobi in Russia in 1839, and the experiment of M. Trouvé, which received the applause due to an apparent success at the Paris Exposition of Electricity last year. A controllable balloon proposed by M. Tissandier, and the electro-motor which he would apply to its propulsion, are also mentioned. The second part of the work embraces a full and detailed description of M. Trouvé's electrical motor, its application, and the degrees of speed attained with it. The whole is hopeful for the ultimate success of electro-navigation.

Annual Report of the Board of Regents of the Smithsonian Institution for 1880. Washington: Government Printing-Office. Pp. 772.

This report, though tardy in appearing, has a permanent value that justifies a notice of it at any time. The record of work done is very full in notices of explorations and special investigations in which the Institution has had a part; the list of acquisitions to the collections and of exchanges is quite large. The "Record of Scientific Progress," which forms one of the appendices, is designed to take the place in part of the "Annual Record of Science and Industry," formerly published by Harper & Brothers, and contains reviews in astronomy, by Professor Edward S. Holden; geology, by George W. Hawes, Ph. D.; physics and chemistry, by Professor George F. Barker; mineralogy, by George W. Hawes, Ph. D.; botany, by Professor William G. Farlow; zoölogy, by Theodore Gill; and anthropology, by Otis T. Mason. Other important articles in the appendix are "Abstracts of the Smithsonian Correspondence relative to Aboriginal Remains in the United States," a description of the Luray Cavern, Virginia; a discussion of the barometric observations of Professor Snell, of Amherst College; an account of investigations relative to illuminating materials, by Professor Joseph Henry; a bibliography of Herschel's writings; and reports of astronomical observatories.

THE PEAKS IN DARIEN, WITH SOME OTHER INQUIRIES TOUCHING CONCERNS OF THE SOUL AND THE BODY. An Octave of Essays. By FRANCES POWER COBBE. Boston: George H. Ellis. Pp. 303. Price, $1.50.

THE first of the essays in this book, "Magnanimous Atheism," affirms the inefficiency of that creed of agnosticism, or of Comtism, to frame a rule for moral guidance; the second, "Hygeiolatry," disputes the doctrine that bodily health is the chief good "for which personal freedom, courage, humanity, and purity, ought all to be sacrificed," and argues that there are numbers of instances in which disregard of life and health is proper and even a duty. Coming to particulars, it attacks the English laws for the regulation of vice. Another essay, on "Zoöphily," is a vigorous but one-sided protest against vivisection. In other papers, Schopenhauer and his pessimism are assailed, and the fitness of women for the ministry of religion is discussed. The essay which gives the title to the book cites a number of instances of cases wherein, in the opinion of the author, "indications seem to have been given of the perception by the dying of the blessed presences revealed to them, even as the veil of the flesh has dropped away." The papers afford lively reading, but the book is one of opinions and sharp thrusts rather than arguments.

THE FIRE-PROTECTION OF MILLS; AND CONSTRUCTION OF MILL-FLOORS: Containing Tests of Full-Size Wood Mill Columns. By C. J. H. WOODBURY. New York: John Wiley & Sons. 1882. Pp. 196. Illustrated.

THE avowed object of this book is to reduce the risk of fire and its attendant evils, as applied to mills, but many of the precautions are applicable to other structures, and especially to all factories. The first portion is devoted to a consideration of those matters of equipment and general management which experience has proved to be efficient in the fire-protection of mills. Under these we notice some practical suggestions regarding fire-pails, and where and how they should be kept ready for use. The various forms of fire-pumps are described and illustrated, the advantages and disadvantages of each being carefully stated. The next subjects in order are hydrants, stand-pipes, drip-couplings, hose-valves, and nozzles; also a table showing the quantity of water discharged per minute from a one-inch nozzle under pressure of from fifteen to eighty-five pounds per square inch. Several systems of "sprinklers," or perforated pipes, intended for the more hazardous parts of mills, are described. The efficiency of these is often impaired by rust and paint obstructing the orifices. The latter should be guarded against by placing tacks in each hole before the sprinklers are painted; the former by the use of a brass bushing. The automatic sprinkler, the author says, is one of the oldest devices for special fire apparatus, the first patent having been granted in 1806. A large number of automatic sprinklers are figured, full size or half size.

The next subject treated is the causes of mill-fires, among which we find that spontaneous combustion holds a prominent place, second only to friction and foreign substances in the picker. Matches and lighting apparatus, of course, are dangerous elements, as well as lightning, fire-works, and stoves. In one case a freshet caused such a rapid oxidation of iron turnings as to set fire to the sawdust that was mixed with them.

The advantages of electric lighting for mills are dwelt on at some length, the different systems being described and the cost compared. The latter contains the results actually obtained at the Globe Mills in Woonsocket, where the expense of lighting a weave-room three hundred feet by sixty-six, by gas, was nearly twice the cost of lighting the same room by electricity, gas costing $2.20 per thousand feet. Only one hundred and seventeen incandescent lamps were employed, where two hundred and sixteen gas-burners had been used, making the cost per light very nearly the same. The dangers of electric lighting are admitted, and the precautions to be taken are enumerated.

The second portion of the book treats of the restriction of injury from fire by means of the application of sound principles of building pertaining to slow-burning construction. The features of bad construction and the elements of safe construction are considered, and formulæ are given for the strength of beams, planks, floors, etc.

The book is handsomely printed in large clear type, on good paper, and bound in "fiery red" cloth, which makes it rather suggestive. It is a book that could be read with advantage by many others than builders and owners of mills, and it is to be hoped that its practical suggestions may accomplish what its author aims at—a reduction in the number and extent of mill-fires, with the attendant loss of life and property.

Easy Star Lessons. By Richard A. Proctor. Illustrated with Forty-eight Star Maps and Thirty-five Woodcuts. New York: G. P. Putnam's Sons. 1882. Pp. 219. Price, $2.50.

The object of this last book of the distinguished astronomer is to teach the star groups, and enable the learner to find them *on the sky*. Instead of the usual star maps that represent the entire visible heavens and require to be held upside down, or sideways, in tracing out the constellations, four maps are given for each month of the year, namely, a northern, a southern, an eastern, and a western map, making forty-eight in all. The maps are printed in blue, the stars in white; the principal stars of each constellation are joined by dotted lines, and the names of the constellation are given, but the usual imaginary pictures of bulls, fishes, and dragons are all omitted, so that the map more nearly resembles the sky than is usual. Lines are drawn to represent the horizons of New Orleans, Louisville, Philadelphia, and Boston; also of London, England. The zenith of each place is likewise given. Several pages of letterpress accompany each set of star maps, and explain the method to be followed in tracing out each group, and woodcuts are employed in the text to exhibit the position of the larger stars as related to the bulls and bears of the sky. This method of separating the real from the imginary will be a boon to the star-gazer and the student, for it is very pleasant to know the stars—to be able, like Milton's hermit, to

> ". . . sit and rightly spell
> Of every star that heaven doth show."

Report of the Commissioner of Education for the Year 1880. Washington: Government Printing-Office. Pp. 914.

The commissioner asserts that the important relation which his department sustains to the interests of education is becoming constantly more apparent; and that the year covered by the present report was marked by a great increase in the amount and value of the information received at the office with reference to the conduct of education in our own and foreign countries, and by a corresponding increase in the public demand for the distribution of information. The department is endeavoring to secure a more exact particularity and definiteness in the educational statistics from the different States, so that they may show more clearly the condition of the schools, the proficiency of the pupils, and the degree of attention that is given to each branch of study. It has succeeded so far that the reports from Ohio give the number of pupils in each of the branches taught, and those of more than a dozen other States give approaches to the result. Advance is claimed in the consideration shown in the arrangement of courses of study to psychological conditions and the necessities of pupil life. An approach has been made in the last ten years toward uniformity in the general outlines of the school systems of the different States, "which seems remarkable in view of the diversity of educational conditions in the several States prior to 1870, the opposite theories which prevailed in different sections, and the great contrast between the newly settled States and older commonwealths in social conditions and available resources." Information concerning rural schools being given now fuller and in more explicit shape than formerly, their deficiencies and wants are in consequence more clearly perceived, and there is ground for belief that improvement in them will be steady and rapid. Women's opportunities to influence education as voters and school-officers have been greatly enlarged in many States, but the commissioner regrets to say that the women have shown more indifference to them than he had expected. The usual annual review of the different classes and grades of schools in the United States is given, but, while it shows the general improvement in efficiency that was to be expected, reveals nothing new that calls for especial remark. Papers are appended on "Education in Foreign Countries," "Industrial Education," "Popular Science Teaching," "Evening, Army, and Summer Schools," "Myopia," the "Physiology of Reading and of Writing," and other topics bearing upon the advancement and improvement of education.

Manual of Blow-pipe Analysis, Qualitative and Quantitative, with a Complete System of Determinative Mineralogy. By H. B. Cornwall, Professor of Analytical Chemistry and Mineralogy in the John C. Green School of Science, Princeton, N. J. New York: D. Van Nostrand, 1882. Pp. 308.

The title of the book before us very fully explains its nature and purpose. Professor Cornwall's skill as a chemist and experience as a teacher peculiarly fit him for the preparation of a manual that shall supply the student with all the needed information for pursuing a complete course in blow-pipe analysis.

The work is similar in plan, but wider even in scope, than Plattner's well-known manual, which was translated by Professor Cornwall in 1872, and has since been the standard text-book. In the present work, many details have been added which tend to lessen the labors of the instructor, and adapt the book to the use of students who are working alone, although it will be readily understood that few persons will be able to acquire skill in a branch requiring such delicacy of manipulation without personal instruction. The apparatus and operations are first fully described and carefully illustrated by numerous woodcuts; special tests are then given for each of the elements, including even the rare metals, for in blow-pipe analysis it frequently happens that the presence of only one or two substances is to be sought, and it is then unnecessary to go through a complete analysis. The fourth chapter, however, contains special schemes for complex substances, and methods for the examination of metallurgical products and paints; also Professor Egleston's scheme for complete analysis, as it appeared in the author's translation of Plattner. The system has been devised with the view of employing the blow-pipe to the exclusion, as far as possible, of wet methods, but a few directions are given for the general operations in wet analysis, and a list of reagents both solid and liquid required for the latter. Mention is made of the use of citric acid, as recommended by Professor H. C. Bolton, for decomposing minerals; also of the glycerine test for boracic acid. We can not help feeling that the addition of a list of Bunsen's "flame reactions" would have added to the value and completeness of the book. The use of spectrum analysis is very briefly described, and an (uncolored) lithographic plate shows the position of the lines and bands which characterize the metals usually sought for in this way.

In the chapter on quantitative analysis, the method of assaying gold, silver, copper, lead, bismuth, tin, mercury, and cobalt and nickel ores is fully described, and the apparatus employed are illustrated. In this sort of work the automatic apparatus, described on pages 180, 181, are very convenient, as a long-continued and steady blast is essential. As the quantity of ore that can be assayed is very small, the operations of quantitative blowpiping are very delicate, and an exceedingly accurate balance is an absolute necessity.

It is well adapted to the assay of alloys, but when ores are to be assayed very great care is required to obtain a fair sample in so small a quantity of material. With these drawbacks, blow-pipe analysis offers many advantages over wet analysis, as it requires no special laboratory, and the apparatus are much more portable.

Chapter VIII contains a description of the important ores and coal, and the last chapter is devoted to determinative mineralogy. In this chapter, the minerals, like plants in a botanical key, are subjected to an artificial classification depending on certain external properties. The classes are then subdivided according to their reaction before the blow-pipe, such as fusibility, odor, or coat on charcoal. The method of writing the mineral formulas is that followed by Plattner and Kobell.

Professor Cornwall's book is, on the whole, so complete and practical, that it will soon take the place of the larger and more expensive manual of Plattner in our leading scientific schools.

Catalogue of 1,098 Standard Clock and Zodiacal Stars. Prepared under the direction of Simon Newcomb. Pp. 314.

This catalogue was commenced at the Naval Observatory for the purpose of obtaining standard positions of reference stars for use in the lunar and planetary theories, especially in the reduction of the older occultations. In 1877 the unfinished work was turned over to the office of the American Ephemeris, and has been completed by Chauncey Thomas, U. S. N., under the personal direction of Professor Newcomb.

PUBLICATIONS RECEIVED.

A Guide to Modern English History. By William Cory. Part II. 1830–'35. New York: Henry Holt & Co. Pp. 567.

History of the Pacific States of North America. By Hubert Howe Bancroft. Vol. I. Central America. San Francisco: A. L. Bancroft & Co. Pp. 704.

Practical Life and the Study of Man. By J. Wilson, Ph. D. Newark, New York: J. Wilson & Son. Pp. 400. $1.50.

The American Citizen's Manual. Part I. Governments, the Electorate, the Civil Service. Edited by Worthington C. Ford. New York: G. P. Putnam's Sons. Pp. 146. $1.

Speech and its Defects. Considered Physiologically, Pathologically, Historically, and Remedially. By Samuel O. L. Potter, M. A., M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 117. $1.

How to Succeed. A Series of Essays by Various Authors. Edited, with an Introduction, by the Rev. Lyman Abbott, D. D. New York: G. P. Putnam's Sons. Pp. 131. 50 cents.

Schelling's Transcendental Idealism. A Critical Exposition. By John Watson, LL. D., F. R. S. C. Chicago: S. C. Griggs & Co. Pp. 251. $1.25.

Swift. By Leslie Stephen. New York: Harper & Brothers. Pp. 205. 75 cents.

Sterne. By H. D. Traill. New York: Harper & Brothers. Pp. 173. 75 cents.

Hints for Sketching in Water-Color from Nature. By Thomas Hatton. Edited by Susan N. Carter. New York: G. P. Putnam's Sons. Pp. 69. 50 cents.

Drawing in Black and White. Charcoal, Pencil, Crayon, and Pen-and-Ink. By Mrs. Susan N. Carter. New York: G. P. Putnam's Sons. Pp. 55. 50 cents.

Potable Water and the Relative Efficiency of Different Methods of detecting Impurities. By Charles Watson Folkard. New York: D. Van Nostrand. Pp. 138. 50 cents.

In Memoriam. Benjamin B. Redding. San Francisco: California Academy of Sciences. Pp. 18.

Is Tubercular Consumption a Contagious and Parasitic Disease? By Bela W. Cogshall, M. D., of Flint, Michigan. Pp. 12.

On Nocturnal Epilepsy, and its Relations to Somnambulism. By M. G. Echeverria, M. D. Lewes: "Sussex Advertiser" Office. Pp. 32.

Forestry Bulletins of the Census Office, 18 to 22.

A Plan for securing Observations of the Variable Stars. By Edward C. Pickering. Cambridge: John Wilson & Son. Pp. 15.

An Evolution Aspect of the Healing of Wounds, with Deductions as to Treatment. By C. Pitfield Mitchell, M. R. C. S., 30 E. 35th Street, New York. Pp. 13.

The Pathology and Philosophy of Sea-Sickness. By C. Pitfield Mitchell, M. R. C. S., 30 E. 35th Street, New York. Pp. 16.

Subscales, including Verniers. By Henry H. Ludlow, U. S. A. New York: D. Van Nostrand. Pp. 16.

On the Prevention of Fires in Theatres. By C. John Hexamer. Philadelphia: "Merrihew" Print. Pp. 18.

Some Points on the Administration of Anæsthetics. By George H. Rohé, M. D. Baltimore: Office of the "Medical Chronicle." Pp. 18.

Use of the Ecraseur for curing Deep-Seated Fistula-in-Ano. By J. M. F. Gaston, M. D., of Campinas, Brazil. Pp. 8.

Report of the Bureau of Statistics relative to the Imports, Exports, Immigration, and Navigation of the United States for the Year ended June 30, 1882. Washington: Government Printing-Office. Pp. 112.

Analyses of Beethoven's First and Second Symphonies. By George Grove, D. C. L. Boston: George H. Ellis. Pp. 16 each. 15 cents each.

Address delivered by the President of the Homœopathic Medical Society of Pennsylvania, September 5, 1882. By John C. Morgan, M. D. Pittsburg: Stevenson & Foster. Pp. 13.

Radiant Heat an Exception to the Second Law of Thermo-dynamics. By H. T. Eddy, Ph. D. Cincinnati. Pp. 12.

"The American Journal of Physiology." Edited by D. H. Fernandes, M. D. Vol. I, No. 1. Indianapolis, Indiana. Pp. 8.

The Gulf Stream. Additional Data from the Investigations of the Coast and Geodetic Steamer Blake. By Commander J. R. Bartlett, U. S. N. Pp. 16. With Map.

Phonetics of the Kayowe Language. By Albert S. Gatschett. Pp. 6.

A Dictionary of Music and Musicians. Edited by George Grove, D. C. L. Parts XV and XVI. London and New York: Macmillan & Co. Pp. 272. $2.

Sanitary Tracts. Issued by the Citizens' Sanitary Society of Brooklyn. Pp. 12. 5 cents.

Ottawa Field-Naturalists' Club. Transactions No. 3. Ottawa, Canada: Citizens' Printing and Publishing Company. Pp. 66. With Two Plates.

The Practice of Gynæcology in Ancient Times. By Edward W. Jenks, M. D., LL. D. Chicago, Illinois. Pp. 46. With Two Plates.

Statistics in Relation to Gold and Silver. Compiled by E. J. Farmer. Cleveland, Ohio. Pp. 37. 25 cents.

The Analogy between Sound and Color. By G. G. Finn. Cleveland, Ohio. Pp. 22.

The Muscles of the Limbs of the Raccoon. By Harrison Allen, M. D. Pp. 30.

Tornadoes. Their Special Characteristics and Dangers. With Practical Directions for Protection of Life and Property. By John P. Finley. Kansas City, Missouri: Ramsay, Millett & Hudson. Pp. 29.

Tornado Studies for 1882. By John P. Finley. Kansas City, Missouri: Ramsay, Millett & Hudson. Pp. 14.

Notes on Physiological Optics. By W. Le Conte Stevens. Pp. 8.

Unscientific Materialism. A Criticism of Tyndall's "Fragments of Science." Fifth edition. By S. H. Wilder. New York. Pp. 16.

A New View of our Weather System. By Isaac P. Noyes. New York: Fowler & Wells. Pp. 51. 25 cents.

POPULAR MISCELLANY.

The Flora of North America.—Professor Asa Gray gave an historical account, at the last meeting of the American Association, of the study and compilation of the North American flora. The first "Flora" of the country was published by Michaux, in 1803. It embraced plants representing the whole region from Hudson Bay to Florida, and contained1, 530 species. The work of Pursh followed about twenty years afterward, and represented a much smaller territory, not extending west of Virginia or north of Lake Champlain, but contained 740 genera and 3,700 species. Dr. Gray himself started on his great botanical work in 1830, while he was an assistant in a doctor's office in New York. It is not exactly known when Dr. John Torrey conceived the idea of publishing a third "Flora of North America," but he invited Nuttall to join him in the work as early as 1832. Arrangements were afterward made with Dr. Gray, and the first volume of the conjoint work was issued in 1838. It was generally thought that the orders remaining to be described could be soon worked out, and the "Flora" completed, but the rapid publication which the fulfillment of such an anticipation required was not possible. Dr. Torrey had already been to Europe and spent a considerable time in the study of foreign herbaria. Dr. Gray also visited Europe at the end of 1838, and spent several months in the same work, paying especial attention to the American herbaria of Michaux, Pursh, De Candolle, and others. A second volume of 500 pages appeared in 1840, and carried the "Flora" to the end of the *Compositæ*. The work was then interrupted by the pressure of other duties, so that the third volume was not added to the series till 1880. The labor of pushing the work to completion is very difficult now compared with what Pursh endured when the species were fewer and the number of specimens collected of each was many times less. The first volume of the present "Flora" contained about twice as many species as Pursh gave for the same orders; and the number of species in these families has increased greatly in the thirty years since its publication. American flowering plants can not now be represented with less than 10,000 species, and the number is increasing daily, so that soon 12,000 may be required. The amount of material collected is vast; additions are constantly pouring into the Harvard herbarium, and the time of the compilers is severely taxed to work it over. The work in the future must be divided up among many persons, each doing a part; and Dr. Gray earnestly solicits the co-operation of all botanists.

The Proposed Geological Map of Europe.—The International Geological Congress, which met at Bologna last year, decided upon the preparation of a geological map of Europe, which should exemplify a uniform terminology and a uniform system of coloring, and appointed an International Committee to superintend the work. The execution of the map will, of course, require many years, but its general plan and the regulations under which it is to be carried on have been already provisionally agreed upon. The map is to be published at Berlin, under the immediate direction of Messrs. Beyrich and Hauchecorne, of the

Royal Prussian Geological Institute. The data from each nation will be furnished through its representative on the International Committee, if it has one; or, if it is a small state, and is not thus represented, by its vice-presidents in the Congress. The map will include the whole basin of the Mediterranean and all of Europe to the eastern slope of the Ural Mountains, and will be made upon a scale of 1 to 1,500,000. It will therefore cover a space of 372 by 336 centimetres, or about twelve by eleven feet, and will, for convenience of use and binding, be divided into forty-nine sections of about twenty-two by sixteen inches each. The primary object of the map will be to give a clear representation of geological conditions. It will not be practicable consistently with this to give particular attention to orographical details. The river systems, the principal towns, the more important mountain-ranges, and the curves indicating sea-depths, will be denoted so far as seems fitting. The topographical basis of the map is to be reconstructed on the proposed scale under the supervision of Professor H. Kiepert, of Berlin. The total expense of the work is estimated at 80,000 marks, or in the neighborhood of $20,000, and is to be borne by the states interested, the eight largest states contributing each one ninth, and the smaller states together the other ninth, of the whole. The subscription price for the first edition will be 80 marks, or about $20, a copy of the whole map. The price will afterward be raised to 100 marks, or $25.

Origin of Petroleum.—The Huron and Cleveland (Devonian) black shales of Ohio contain from 2 to 22 per cent of organic matter, which Dr. Newberry regards as of marine origin, and are the source of some of the petroleum-wells. Decomposition has been carried on so far that all structure seems to have been obliterated; but Dr. Orton stated, in a paper read before the American Association, that he had discovered the organic substance to consist of sporangia or spore-cases of *Lycopodiaceæ*. He had found numerous resinous disks of from $\frac{1}{200}$ to $\frac{1}{50}$ of an inch in diameter, translucent, amber-colored, appearing as a rusty crust, with ridged and furrowed surfaces, burning freely, insoluble in alcohol, and sometimes having stem-like attachments. Different beds afford disks of different sizes. The Pennsylvania and New York petroleum-wells originate in the equivalent of the Ohio black shales.

A Medal to Pasteur.—A medal commemorative of his remarkable discoveries was presented to M. Pasteur at the sitting of the French Academy of Sciences, June 26th, by M. Dumas, on behalf of a committee of scientific men and friends and admirers of the distinguished investigator. M. Dumas reviewed briefly the great services M. Pasteur had rendered to science, art, and industry, through his researches among the vital organisms of fermentation, and closed by saying: "My dear Pasteur, your life has only known successes. The scientific method, of which you make certain use, owes you its finest triumphs. The Normal School is proud to count you among the number of its students; the Academy of Sciences is elated at your researches; France ranks you among her glories. . . . Science, agriculture, industry, humanity, will feel eternal gratitude to you, and your name will live in their annals among the most illustrious and the most venerated." Pasteur replied modestly, acknowledging his obligations to his teachers, and said: "Hitherto great eulogies have inflamed my ardor, and only inspired the idea of rendering myself worthy of them by new efforts; but those which you have addressed to me, in the name of the Academy and of learned societies, truly overpower me."

Were the Mound-Builders Indians?—Dr. Hoy read a paper at the American Association in support of the view that the mound-builders were the ancestors of our present Indian race. He held that the age of the mounds had been exaggerated. The growth of large trees upon them is not certain evidence of great age, for some trees grow very fast. It was also a mistake to suppose that the mound-builders could be distinguished from Indians by their being an agricultural people. The Indians have largely tilled the ground. De Soto lived with his army four years among the Indians of the South, and quartered his two hundred and eleven horses for forty days in one spot. The absence of traditions about the mound-builders can not be regarded as evidence of separate origin; it is a fact that the Winnebagoes and Menomonees have no traditions going as far back as to Marquette, or even to John Carver, not a century ago; and, in truth, their traditions are so short that they deny that the Indians ever used stone arrow-heads. The author concluded that there was abundant evidence of an Indian origin in the mounds—including the finding of European implements in them that must have been placed there when they were made—from the Gulf of Mexico to Northern Wisconsin.

Dr. Hoy also discussed the question of the origin of the copper implements that are found in the neighborhood of Lake Superior. He remarked that the explorers of the St. Lawrence, Lake Superior, and the Eastern coast, all say that the Indians had these implements, and that the copper-mines of Lake Superior show no evidences of great antiquity. The Chippewas and Winnebagoes both have copper ornaments. Professor Butler has a copper spear-head, plowed up in Wisconsin, containing part of an iron rivet, which had doubtless been made or used after the Indians had traded with the whites, and had had access to iron. The author was of the opinion that the Indians of the Lake Superior district made copper implements for themselves, and also for extensive barter, and did not see how any reasonable man could assert that the Indians knew nothing about the use of the native metal. Professor Putnam discussed the same subject in his paper on the North American copper implements and ornaments under his charge in the Peabody Museum. He had no doubt that the Indians used copper, and that its use was contemporary with that of polished stone implements. The native copper was hammered, not molded, into shape; and the speaker described the way in which the processes were carried out. Some ornaments that had been connected with Christianity were really only shaped as they were easiest to make. Some classical-looking ear-rings were shown, which had been made from native copper beaten out.

Formation of Prairies.—Mr. H. D. Valin, of Chicago, has proposed a new theory to account for the formation of prairies and the elevation of the country west of the Mississippi. Noticing that the prairies rest generally on Silurian rocks, he believes that they represent ground which has always been inundated, or subject to periodical overflows. The waters, when high, washed away the rocks of the bluffs, and deposited on the level surface beneath them the clay resulting from the erosion; while the *detritus* forming the sod of the prairie dates always from the last inundation. The constant exposure of the prairie-soil to submersion accounts for the absence of trees. The land has risen partly by deposition, but in large part also because of the elasticity of the earth's surface, "which, like matter in general, always tends toward an equilibrium. For instance, the highest mountains weigh about the same on the surface of the earth that the deepest ocean does, otherwise their respective levels would come into one. Now, as the *detritus* of the rocks is carried by streams into the sea, the porous material grows heavier, though not increased in size, and the equilibrium is forcibly re-established by a slow upheaval of the land. The pressure exerted laterally by such upheaval is, likely, the origin of volcanoes, geysers, and earthquakes."

Physiological Analogies of the Roman Letters.—Professor A. Melville Bell, in explaining the system of "visible speech" at the late meeting of the American Association, remarked that something like a physiological principle may be found to pervade our Roman alphabet. The actions of the lips, the most obvious of the speech-organs, would naturally be the most definitely indicated; and it is among the labial letters that we find the most numerous illustrations of an apparently physiological basis. The rounded form of the lips in pronouncing O is, for example, very suggestive of the circle, which is the emblem of that element; and in the letter B we have a perfect representation of the profile of the closed lips. The letter P as compared with B, seems to suggest a sound of similar organic production, but lacking something of the B sound —and this is the exact physiological relation of the elements. B and P are alike, excepting that B has a vocal murmur, which is wanting in P. The letters P and F present another instance of physiological consistency, the closed part of P being opened in F, as if to indicate a sound of similar formation without obstruction of the breath. The letter C exhibits the outline of the back of the tongue in pronouncing the hard sound of the letter, and the kindred letter G consistently shows an element of similar formation, but with the addition of something that is lacking in C. The letter K, a duplicate for the sound of C hard, consists of a C, angular instead of rounded, in contact with a posterior line, and thus very suggestively denotes the action of the tongue against the roof of the mouth. The letter T, in the same way, appears to denote the position of the tongue in pronouncing the sound; the roof of the mouth being denoted by the horizontal line, while the vertical line shows the upward direction of the tongue to contact with the palate.

Antiquity of Man in America.—"The Geological Testimony to the Antiquity of Man in America" was considered by Professor Willis De Hass, in a carefully prepared paper which he read at the American Association. After referring to a skeleton disinterred at Natchez, Mississippi, of very uncertain antiquity, and the remains yielded by the Trenton gravel formation, which he was disposed to place at even a pre-glacial period, the speaker mentioned the caverns as constituting the best sources of information as to human antiquities. They show evidences of an existence of man on this continent long antedating the mound period, and would, he had no doubt, hereafter become as celebrated for human antiquities as were the caverns of Belgium and France. He attributed the ancient copper-workings of Lake Superior to a prehistoric race, and asserted that a greater amount of labor had been performed by its miners in a space of less than two thousand acres than two thousand men working twenty years could perform in our time. All the mines of the Lake Superior region, he added, gave evidence of having been wrought by a prehistoric race. Professor De Hass did not, however, consider that the mounds and mural works of the West and South bore evidence of a high antiquity—or of more, perhaps, than two thousand years. They might be assigned to a people intermediate between the mound-builders and the Indians.

Ancient Cults among the Berbers of Morocco.—Dr. Haliburton, of Ontario, has taken advantage of a recent sojourn in Morocco to study the vestiges of ancient cults of Europe and Asia which are still preserved among the Berber tribes. Here he found the crude stories of the twelve labors of Hercules, of Apollo, of Minerva, of Isis and Osiris, of Belus and Astarte. Numerous observations indicated that here, too, must have been the home of the myth of Saturn and of the golden apples of the Hesperides. A very interesting part of the paper on this subject communicated to the American Association by Dr. Haliburton was the mention of many names and stories connecting these people with the Bible, such as those of the gold of Ophir, the Queen of Sheba, the land of Havilah, and of the vessels of beaten gold and silver in the temples. On the last point the speaker dwelt at length, presenting numerous brass and silver works and jewelry, made by the Shillooks in our own day. The fables of Atlas and the Atlantes were traced in the very cradle of the people themselves. The fable of the head of Medusa was traced to this place in accordance with the story of Herodotus, that it arose from the custom of the people of a certain region wearing leather trappings on their heads. Dr. Haliburton showed a leather ornament of a powder-horn with a fringed leather border, like that on a Sioux saddle-ornament, and similar to those described by Herodotus. The whole paper was full of allusions to classic mythology and Biblical story.

The American Indians and the Aryan Race.—"Have the Indians come from Europe?" was the subject of a paper read by Horatio Hale, of Clinton, Ontario, at the recent meeting of the American Association. After tracing the course of emigration of the leading stocks of the Indian tribes, as indicated by their languages, and the modifications they seemed to have undergone, the author remarked that the fact that the course of emigration seems to have been from the Atlantic coast toward the interior might be regarded as evidence that the ancestors of our Indian tribes were emigrants from Europe. Reference was made, in support of this view, to the close resemblance in structure between the Basque and the Indian languages. It was suggested, also, that if the Aryan intruders, entering Europe from the East, encountered and absorbed a population resembling the American aborigines, the fact would account for the great change which the Aryan speech underwent in Central and Western Europe. It would also account for the remarkable change which took place in the character of the intruding race. The Aryans, who in the East have always been a submissive and contemplative race, devoid of the idea of popular government, became, in Europe, a high-spirited, practical, and liberty-loving people. Mr. Hale concluded that the natives of modern Europe were a people of mixed race, forming a transition, in physical and mental traits, between the Eastern Aryans and the aboriginal Americans.

Wine from Beets.—Induced by the havoc wrought among the French vines by the phylloxera, the Messrs. Brin, of Paris, have patented processes for making red and white wines from red and white beets. The roots may be used raw, but it has been found preferable to cook them. Perfectly sweet and clean roots are chosen, and after being cooked are reduced to a pulp. The juice is then pressed out and strained, and put into vessels of wood or cement, but not of metal, with a certain quantity of water, if desired, to ferment. This process is aided by admitting steam or hot water through serpentine coils placed in the receivers, and adding some of the ordinary ferments, and alcohol, according to the degree of strength that is wanted. After fermentation the whole is strained with tannin. The wine obtained by this process is said to possess all the properties of wine from grapes, and is treated henceforth like grape-wine. It is well adapted, by virtue of its sacchariferous qualities, to improve wines poor in sugar and rich in tannin. The red wine, moreover, is good for adding color to other wines that need it. The white wine is supposed to be improved by the addition of a little nitric acid at the moment of fermentation, after which the whole is "well shaken."

Analogies of Ancient Old World and American Customs.—Dr. Phené called attention in the American Association to some hitherto unnoticed affinities between ancient customs in America and other continents. He mentioned customs which have been shown to have existed in the great river-valleys of our countries or have been revealed in the mounds, that had parallels in various European and Asiatic countries. Among them were those indicated by the occurrence of figures of serpents, alligators, or mythical dragons, and the human form, the characteristic features of which were curiously persistent in each case. Some of the shapes of the semi-barbaric age of Mexico corresponded with forms in Devonshire and South Wales. In the vicinity of some such figures of this character in the west and east of the south of England were enormous intaglio representations of the human form corresponding to the intaglio forms at Milwaukee, Wisconsin. Drawing attention to several other apparent correspondences, the speaker said that they were the result of a practice and culture transmitted with concurrent customs by way of the Pacific from one continent to another.

Russian Geological Research. — The mining department of the Russian Government has founded a geological institute for the purpose of centralizing all geological research in Russia, and preparing a detailed geological map of the empire. The empire has been explored geologically in a general fashion by several men of science, who have given accounts of observations, the most complete of which is that of the English geologist Murchison. This is still a classic work, and all recent geological maps of Russia are only improved editions of the one prepared by him. A continuous series of geological expeditions, which have considerably advanced the knowledge of Russian geology, have been conducted by the mining department and private scientific societies in connection with the universities; but all these researches have wanted the system and connection which can be given them only by referring them to some central organization and direction like the newly established institute.

Action of Citric Acid on Minerals.—Professor H. C. Bolton read a third paper at the recent meeting of the American Association on the decomposition of minerals by citric acid, detailing the results of his later researches on the subject. Some of the conclusions expressed in the first of his two previous papers were modified in the second paper, in view of the results obtained by the prolonged action of the acid. In the third series of experiments Professor Bolton found that many species which resist the brief action of a boiling concentrated solution of citric acid are more or less completely decomposed by prolonged contact with the same solution at the ordinary temperature of the work-room. He has drawn up a table, in accordance with the last series of tests, of thirty-two minerals or classes of minerals which are classified as those that are quickly, slowly, very slowly, or not, decomposed by citric acid.

In an American Association paper Dr. Britton describes a Post-Tertiary, pre-glacial deposit, near Bridgeton, New Jersey, compact enough to furnish a building material, which contains casts of the shells of the hard clam, with silicified wood, and in which very fine impressions of leaves—including those of the sweet-gum, or liquidambar, viburnum, zizania, and elm—are occasionally found.

NOTES.

According to the Census Bureau's bulletin of the statistics of the lumbering industry of the United States for the year ending with May last, $181,186,122 are invested in 25,708 establishments for the preparation of lumber, and the total value of the products for the year was $233,367,729. Michigan leads the States in this industry with 1,649 mills, $39,260,428 capital, and $52,449,928 of products. Pennsylvania is second, with 2,827 mills, $21,418,588 of capital, and $22,457,359 of products. Next are Wisconsin, with $19,824,059 of capital, and $17,952,347 of products; New York, $13,230,934 of capital, and $14,356,910 of products; and Indiana, with $7,048,088 of capital, and $14,260,830 of products. Maine, which used to be considered emphatically the "lumber State," is now seventh in rank, having 848 mills, with $6,339,396 of capital, and $7,933,868 of products.

Dr. Desiré Charles Van Monkhoven, who died on the 25th of September last, just forty-eight years old, was at once distinguished as an astronomer, a chemist, an optician, and a photo-chemist, and was also an active and capable man of business. He was best known by his researches in optical questions bearing on photography, and particularly by his practical applications of them in the Monkhoven solar enlarging apparatus, the Monkhoven tissue for carbon printing, and the Monkhoven gelatine plates, which he invented, and of which he directed the manufacture. He was the author of a general treatise on photography and of papers on his spectral and other researches, contributed to various periodicals.

On the 22d day of April, and on rainy days afterward, the water in some parts of the city of Lille became unfit for use. M. Géard, investigating, found the cause of the trouble to be the growth of a mucidine of the genus *Cremotryx*, which, greedily absorbing iron, produces in the pipes masses of ochreous matter, the putrefaction of which disengages sulphureted hydrogen in considerable abundance.

A venomous lizard has been presented to the Zoölogical Gardens of London by Sir John Lubbock. It is called *Heloderma horridum*, or horrid warty-skin; it is from Mexico, and is described as about "one foot and a half in length, of a somewhat thickish form, and with a rather short, pointed tail. Except in color its aspect is not prepossessing." It is of a pale ochre, or corn-color, coarsely reticulated with black marks. All of its teeth are connected with poison-glands.

Mr. W. O. Crosby, of Boston, proposes to account for the origin of the seams running in three directions, by which many rocks are cut up into rectangular blocks, as from earthquake-action. Professor H. F. Walling, of Washington, agrees with him. When the papers of these gentlemen were read in the American Association, Professor Newberry, having expressed a sense of obligation to the authors for bringing the subject forward, said that he was inclined to think magnetic currents may have had some part in the production of the joints. Professor Hall called attention to the joints in the clays at Albany, which could not well have been subjected to pressure.

A correspondent of the London "Daily News" states that some interesting objects have recently been found in Neufchâtel which are considered by Swiss archæologists to throw a new light on the history of the lake-dwellers. Among the objects are a carriage-wheel with an iron rim, iron swords, and many human bones.

HENRY DRAPER.

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THE GREAT COMET OF 1882.

By Professor C. A. YOUNG.

THE comet which is fading in the morning sky is one of the most interesting that has ever appeared. Few, if any, have ever been more brilliant, and though others have been larger, and have continued visible for a longer time, none of them have presented more remarkable phenomena.

Of late we have been much favored in the matter of bright comets. According to the list given by Humboldt in his "Cosmos," it appears that the average interval between such apparitions for the last five centuries has been something like eight years. During the last fifty years the frequency has been about the same, conspicuous comets having appeared in 1835, 1843, 1858, 1861, 1862, and 1874. But since the beginning of 1880 we have already had five which were visible to the naked eye, and three of them comets of the highest rank. The comet of 1880 was indeed visible only in the southern hemisphere; but we all remember the fine comet which appeared in June, 1881, and was not much, if at all, inferior to the present one. Schäberle's comet, which followed in August, would have been regarded as very satisfactory had its predecessor been less brilliant; and Wells's comet of last summer, though not well seen in the United States, was a very respectable comet in South Africa.

It is not yet certain when or where the present comet was first seen, but, so far as now appears, the priority belongs to Dr. Gould, or one of his assistants, at the observatory of Cordoba in South America. In a private letter to Mr. Chandler, of Cambridge, mainly occupied with other matters, Dr. Gould, under date of September 15th, mentions that a brilliant comet had been visible there near the celestial equator for "more than a week": he had already two observations, and was waiting for clear weather again in hopes of being able to catch it on the meridian. This would put its discovery on or before September 7th. It was seen on the 8th by Mr. Finlay, an assistant in the Royal Observatory at the Cape of Good Hope; and on the 12th it was observed at Rio Janeiro, by Cruls, who telegraphed the news to Europe, announcing it (erroneously) as the expected comet of 1812 on its return. We have not yet sufficiently full accounts from the southern observatories to know whether it was lost sight of at all after its discovery, but we have the account of a most interesting and unprecedented observation made at the Cape Town Observatory, on the 17th. Mr. Gill, the director of the observatory, writes: "The comet was followed by two observers with separate instruments right up to the sun's limb, where it suddenly disappeared at $4^{h.} 50^{m.} 58^{s.}$ local mean time." This was about an hour and a half before its perihelion passage.

A few hours previously it had been independently discovered by Mr. Common in England, in the full blaze of sunlight, and clouds alone prevented him from making the same observation as Mr. Gill.

It is evident that the comet must have been most intensely brilliant to be visible under such circumstances. When it passed on to the sun's disk (it was between us and the sun at the time), it disappeared, being either transparent, or else practically as bright as a portion of the sun's own surface. If this comet had been in the place of the little "Tewfik" which was seen close to the sun at the time of the Egyptian eclipse last May, it would have been something to remember.

On September 18th the comet had reached a greater distance from the sun (about 3°), and had become so conspicuous that it was simultaneously rediscovered by a multitude of observers in all parts of the world, and accurate determinations of its position were made at several observatories. On the next day every one had heard of it, and people interested in astronomy thought and talked of nothing else.

On the 19th and 20th the comet was still easily seen by the naked eye. On the 21st it was visible only in places when the air was very clear, and the sky darkly blue. On the 22d a curious observation of it was made at Paris by M. Mallet, who, at the request of M. de Fonvielle, ascended for the purpose in a balloon provided by the latter, thus getting above the clouds with which the city was thickly covered. Of course, it was not possible in this manner to make any precise determination of position, but the aëronaut obtained a fine view of the celestial visitor.

For a few days after this the comet does not appear to have been observed until it had receded far enough from the sun to become visible before sunrise. Then, for a while, during the early days of October, it was a most magnificent object, with a head at first rivaling Jupiter in brightness, and a tail which, though not of unusual dimensions, never much exceeding 60,000,000 miles, was remarkably well defined, dense, and luminous. It moved slowly toward the south and west, and when, once in a while, a clear morning permitted the view, it was seen to be growing fainter and more diffuse, though not smaller.

To the naked eye or opera-glass it has perhaps presented fewer phenomena of interest than some other comets—that of 1858, for instance; it has not exhibited any of the peculiar secondary tails or straight streamers which were so characteristic of that comet, nor has the striation of the tail been marked, though evident enough on close inspection.

From September 27th to October 1st, however, the tail was "rifted." There was one obscure streak extending from the nucleus through its whole length, described both by Ricco, of Palermo, and Dr. Hastings, of Baltimore, and the latter mentions another fainter one parallel to the first, and shorter.

On October 2d the tail, as seen at Princeton, was about 14° long, exceedingly bright and sharp in its outlines, slightly curved and convex to the horizon. It was especially well defined near the head, and almost equally so on both sides. On the 4th the upper edge was veiled and rendered indefinite by a faint nebulosity which appeared to have emanated from the head. Ricco's drawing of it, as seen at this date in the clear Italian sky, shows something resembling a bright comet, enveloped in a fainter one; but the smaller one is eccentric, and south of the middle of the hazy envelope.

On the 10th this external nebulosity had considerably increased. Professor Smith, of Kansas University, noticed on the 9th a pale stream of light with parallel edges, and nearly as wide as the tail of the comet, extending toward the sun. On the 15th the phenomenon had become much more conspicuous. The streamer was now over half a degree in width, well defined at both edges, of nearly uniform brightness throughout, though nowhere as bright as even the faintest portions of the tail, and extended from its origin, a degree or two above the nucleus, to a distance of two or three degrees below the head, where it faded out. The dotted lines in Fig. 1 indicate its form and dimensions.

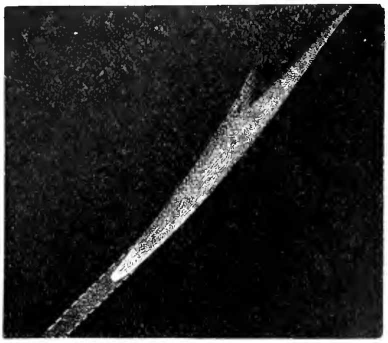


FIG. 1.—OCTOBER 15, 1882.

This streamer, which remained visible only a few days, may have originated in the enveloping comet of Ricco's figure just spoken of, but no other comet is known to have shown anything of the kind. It is not to be confounded with the sunward jets sometimes ejected by cometary nuclei, nor did it at all resemble the anomalous tail, directed toward the sun, shown by Pechüle's comet (in December, 1880), in addition to its ordinary tail.

On October 9th, Schmidt, of Athens, announced the discovery of a small companion comet, 4° southwest of the large one, and moving parallel with it. So far as we know, no one else has observed this companion, though it was carefully looked for at Washington, Princeton, and elsewhere. On October 21st, however, Mr. Brooks, of Phelps, New York, observed either the same or another one, some 8° south and east from the large comet. Like Schmidt's companion it was very faint (though large), and we have seen no observations of it from other sources. We have no means of ascertaining whether these attendants accompanied the comet on its way to the sun as separate objects, or whether they are fragments detached from the main body.

Mr. Brooks seems to think that the nebulous mass observed by him was in some way connected with the faint envelope and streamer just spoken of, which is not unlikely.

When the writer first saw the comet, on September 19th, it was impossible, with the great twenty-three-inch equatorial, to make out much except the nucleus itself. The comet was so near the sun that the object-glass could not be screened from the direct sunshine, which filled the whole field with glaring light. The finder of the instrument is itself, however, a powerful telescope of five inches aperture, and this was perfectly screened by the great tube, so that it furnished an admirable view of the beautiful object. To the naked eye the comet looked like some white-winged bird in swift flight toward the sun. The telescope showed the wings to be long, curved streams flowing backward from each side of the head—backward, that is, with reference to the sun; but they were, of course, really in advance of the comet, which at this time was receding from the sun. The head of the comet had for its center a small round and brilliant nucleus, not well defined, but rather a nebulous star, some 4″ in diameter; in front of this at a distance of perhaps 30″ was an "envelope," and there was a second one at a distance of 2′ or 3′. They were connected by a pair of eccentric circular arcs, and these arcs, coalescing with the outer envelope and prolonged, formed the skeleton of the "wings." Back of the nucleus, traces of the usual dark stripe could be detected. Fig. 2 presents the main features in outline, and every one will notice its close resemblance to Brodie's picture of Coggia's comet as seen on July 13, 1874. (The picture alluded to forms the frontispiece of Chambers's "Descriptive Astronomy," third edition.)

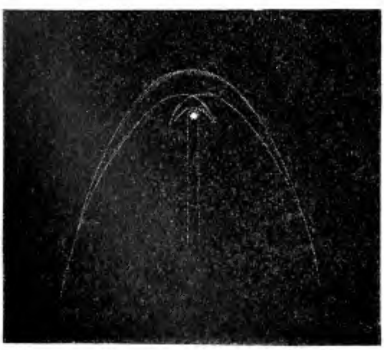


Fig. 2.—Head of Comet September 19—5-inch Telescope.

On the next day the comet was seen at Princeton for a few moments through clouds, just long enough to get imperfect observations for position, but nothing more. It was noticed, however, that the eccentric arcs had disappeared. On October 2d the comet was observed for more than an hour before daybreak with the great telescope. The most notable features were a single bright cap or envelope at a distance of about half a minute from the nucleus, and the nucleus itself, which, instead of being round, was considerably elongated. There were, however, no jets, or starfish-like projections such as the comet of 1881 presented so often. There was not much of structural detail to be made out in the head of the comet, but the dark stripe behind the nucleus was very conspicuous. This dark stripe, by-the-way, is a very remarkable phenomenon, not yet explained, so far as we know, though observed in most large comets. The common impression is, that it is merely a space behind the nucleus, screened as it were by the nucleus itself, from the rush of luminous matter which is being driven backward by the sun's repulsion. But if this be so, then, as Mr. Proctor has pointed out, in a recent article, there is no reason why it should appear so well defined and so dark. The cross-section of the tail, a little way behind the nucleus, was, in the present case at least, 100,000 miles in diameter: now, merely taking away the luminous matter from a tunnel 6,000 or 8,000 miles in diameter along the axis of the tail, could make but little difference with the amount of light received by the eye at a distance. If there were no tunnel, we should get from the central line of the tail the brightness corresponding to a thickness of 100,000 miles of luminous matter. Boring the tunnel would only reduce it to some 90,000 miles, and the difference would be hardly perceptible.

It seems more likely, if the writer may venture the suggestion, that the stripe is a stream or beam of non-luminous, cooler vapor or gas, which is nearly opaque to the radiation emitted by the same kind of gas when luminous, and therefore cuts off all the light from whatever portions of the comet's luminous drapery is behind it; in the same way that cool sodium-vapor, for instance, is relatively opaque to the light of a sodium-flame. If this is correct, the dark stripe ought not to be black, but just about half as bright as the neighboring nebulosity; which corresponds to the actual fact. If one could catch a star passing behind the stripe, it would perhaps be easy to settle the question. At any rate, if the star shone more brightly when in the stripe, we might be sure that the hypothesis is wrong. The star should be dimmed a little, if anything, though, of course, *star*-light would not be so much affected as the light from cometary matter. Mr. Proctor has suggested a different hypothesis, which seems to the writer rather less probable, but there is no time to discuss it here.

On October 4th the nucleus had become much more elongated, so as to be shaped something like an Indian club. The envelope, which was conspicuous on the 2d, had disappeared, or degenerated into an indefinite nebulosity, and the dark stripe had become much fainter.

Continued bad weather prevented observation until the 10th, and on this date the nine-and-a-half-inch telescope of the School of Science Observatory was used. A great change had taken place. The nucleus had become an irregular, spindle-shaped streak some 40″ long, made up of six or eight star-like knots of luminosity connected and veiled by shining haze. One of these knots, about a third of the way from the sunward extremity, was considerably larger and brighter than any of the others, and should, perhaps, be considered as the true nucleus. The next one beyond it (reckoning from the direction of the sun) was second in size, and separated by an interval of 2″ or 3″, the space being filled, however, with nebulosity. The dark stripe was still visible, but directed, not along the prolongation of the nuclear streak, but inclined at an angle of 8° or 10°, while a *bright* jet from the nucleus, two or three minutes in length, touched one side of the dark stripe, and kept nearly in the axis of the tail.

Fig. 3 is an attempt to illustrate the appearance and relation of things by a mere outline sketch, which, of course, can not be considered in any sense a *representation*, since it fails entirely to give an idea of the shading and gradation of light. The head of the comet presented no definite outline whatever, and the nucleus very little. The knots were mere condensations of brightness in the midst of diffuse light. When the dawn came on, the fainter parts successively disappeared, so that at a certain stage the nucleus seemed to be divided into two portions. A small telescope would probably show things in the same way even before dawn, and this is undoubtedly the origin of the reports that the comet had split in two.

FIG 3.—HEAD OF COMET OCTOBER 10, 1882.

This great and unprecedented elongation of the nucleus is a most remarkable phenomenon. If it had occurred at or near the time of perihelion passage, it might have been naturally attributed to the divellent action of the sun's attraction ; but it is a little difficult to see why the thing should have pulled out and come to pieces in such a way after getting safely by the crisis. It is worth noting that this peculiarity of the comet adds greatly to the difficulty of making accurate observations of its position : one does not know just upon what point to direct his instrument.

Continuous cloudy weather prevented any observation of the comet until the 15th. On that date the appearance of things as seen in the great equatorial was very much what it had been on the 10th with the smaller telescope. There were no envelopes, and the only "jet" was the bright streak following the nucleus. The dark stripe had wholly disappeared, as if obliterated and replaced by the bright one. The "knots" in the nucleus were seen to be irregular in form, and were arranged not in a straight line, but in a somewhat broken curve, conforming to the curvature of the tail, which at this time extended 18°, and was fully 60,000,000 miles in length. The bright stream originated not at the extremity of the nucleus, but came out tangentially from the convex side, and perhaps had its source in the largest of the knots, which was now the third from the sunward extremity. The whole length of the nucleus measured 48½″, corresponding to a length of more than 40,000 miles, the diameter of the largest single mass being about 5,000 or 6,000 miles. The only other observation we have been able to make at Princeton was nine days later, on October 24th. No material changes were noticed, though the comet was very much fainter. The same lengthened granular nucleus continued, and seems likely to persist until the comet disappears.*

The spectroscopic observations have been very interesting. On September 18th the French physicist Thollon was an independent discoverer of the comet, coming upon it accidentally in sweeping around the sun. His spectroscopic apparatus consists of a so-called siderostat, the mirror of which throws the rays from the object to be examined upon the lens of a horizontal telescope nine and a half inches in diameter and about twenty feet long. At the focus of this telescope in a darkened room is placed a spectroscope, and, of course, this may be of any form and power best suited to the occasion. In the present case he used an instrument with a single prism of high dispersive power. The most marked feature of the spectrum was the presence of the lines of sodium in the spectrum of the nucleus. They were very bright, and were displaced toward the red by an amount equal to about one fourth of the interval between them, thus indicating that the comet was rapidly receding from the earth. A very narrow, bright, continuous spectrum was also shown by the nucleus. In this the dark lines of Fraunhofer were not conspicuous if visible at all,

* Later observations, on November 4th, show the same general characteristics. The nucleus, if it can be so called, was now 93″ in length, or more than 90,000 miles. Three stellar points could be detected in the forward portion of the nucleus, but only two in the other. The separation between the two brightest points was about 10″. The spectrum showed no new developments. To the naked eye the comet was unexpectedly bright, although now distant from both sun and earth nearly 140,000,000 miles. The head looked like a fourth-magnitude star, and the tail was 16° long and 4° wide at the extremity. On November 20th the nucleus had almost vanished, appearing merely as a brighter streak in the structureless nebulosity of the head. The tail was still nearly as large as ever, and easily visible without telescopic aid, though of course much fainter than on the 4th. The comet has held out remarkably, and, so far as now appears, it may be observable for a long time yet, especially in the southern hemisphere.

showing that the principal brilliancy of the comet was not reflected sunlight. The usual carbon bands of the cometary spectrum were not visible through the sky illumination, and no other bright lines except those of sodium were seen by Thollon. On the 22d the comet's spectrum was observed in the early morning just before sunrise by Ricco, of Palermo. He reports his observation thus: "The spectrum was formed of the narrow continuous spectrum of the nucleus, traversed by a large and strong line of sodium (D); by enlarging the slit I saw a globular, monochromatic image of the nucleus and coma. Besides the line of sodium many others were present, but, my spectroscope not having a micrometer, I did not determine them. I observed a band in the red, a line in the yellow near and after D, two others in the green, and an enlargement of the continuous spectrum in the green and blue." It is exceedingly unfortunate that the position of these lines could not have been determined, at least approximately. No one can predict when such an opportunity will occur again.

The weather in this part of the country was abominable up to November. The writer attempted to get spectroscopic observations on September 20th, but was foiled by clouds, and has since succeeded only on October 2d, 4th, 10th, 15th, and 24th. On the first of these dates the sodium-lines were still easily visible, though not conspicuous. The carbon bands were magnificent, especially the brightest one (in the green), in which could be clearly seen the three fine lines observed in the spectrum of Coggia's comet. The band in the violet was very faint. The nucleus gave a strong continuous spectrum, on which the carbon bands were superposed; and in the tail the proportion of white light (continuous spectrum) to carbon light appeared to be about the same as in the nucleus. The bands could be followed far out into the tail by widening the slit, but were lost before the continuous spectrum quite vanished. No dark lines were made out. On the 4th the results were the same, except that the sodium-lines were very hard to see, and they disappeared entirely before the next date. The later observations added nothing more. It is much to be hoped that, when the different results of all observers come to be collected and published, something will be found to supply what is so unfortunately wanting in Ricco's most interesting but incomplete observation—*hiatus valde deflendus.*

The highest interest of the present comet lies in its orbit, however, its relation to preceding comets, and its possible speedy destruction by the sun. Almost as soon as it appeared, Professor Boss in this country and Hind in England proposed the hypothesis that it is identical with the great comet of 1880, the period of the latter comet having been shortened by some resistance. If so, this comet will be back again in a few months, and before long must fall upon the sun. They have weighty arguments on their side, but on the whole a different conclusion is more probable.

On September 17th the comet passed its perihelion at a distance of about 750,000 miles from the sun's center, and within 300,000 of its surface, rushing through the coronal regions with a velocity exceeding 300 miles per *second:* it swept over 180° of its orbit in three hours and a half. Thus far we find in our lists of cometary orbits only four with so small a perihelion distance, viz., the comets of 1668, 1680, 1843, and 1880. (As to the comet of 1668 there is some doubt, because it was only observed for about three weeks, and its motion during that time was such that it answers almost equally well to either of two quite different orbits.) There are half a dozen others with perihelion distances between one and a half and five million miles, viz., comets of 1767, 1816, 1826, 1847, 1865, and 1870; and Wells's comet, which disappeared only a few weeks ago, is just outside that limit, with a perihelion distance of 5,675,000 miles. Now, as to the comets of the first class, we find that, excepting that of 1680, their orbits are extremely similar; their plane and direction of motion are almost exactly the same; the perihelion distances are nearly the same for all; and the axes of the orbits all point to the same part of space; they have all come toward the sun from the same region of the heavens, in the immediate neighborhood of the great star Sirius. In the little table below are given what are called the elements of their orbits: ☊ is the longitude of the node, i the inclination of the orbit to the ecliptic, π the longitude of the perihelion, and q the perihelion distance, expressed as a decimal fraction of the earth's distance from the sun; e is the eccentricity of the orbit; and the — in the last line denotes that the motion is retrograde. The orbits of the first two are

	1668.	1843.	1880.	1882.
☊	357° 17′	361° 12′	356° 17′	345° 50′
i	35° 58′	35° 41′	36° 53′	38° 05′
π	277° 2′	278° 39′	278° 23′	276° 28′
q	0·0047	0·0055	0·0059	0·0076
e	1·0	0·99989	0·99947	0·99997
Direction	—	—	—	—

from the catalogue in Chambers's "Descriptive Astronomy"; that of 1880 is the orbit computed by Meyer, of Geneva, from the whole assemblage of observations, and that of 1882 is the last orbit computed by Mr. Chandler, of Cambridge, and may be found to need some correction when later observations come to hand. Fig. 4 shows in a rough way how these orbits lie in relation to the orbit of the earth, and how very long and narrow the comet's orbit is as compared with the circle described by the earth.

Now, the similarity between these orbits may be explained in two different ways. It might be accounted for by supposing that we have to do with different visits to the sun of a single comet, or that we have here a group or family of comets, very likely of common origin, but separate, and following each other. Hoek, of Utrecht, showed some years ago that such comet-families exist. When we compare the orbits of the comets of 1843 and 1668 there is nothing that forbids the idea of their identity. The differences are no greater than probable perturbations might account for. Then, again, the comets of

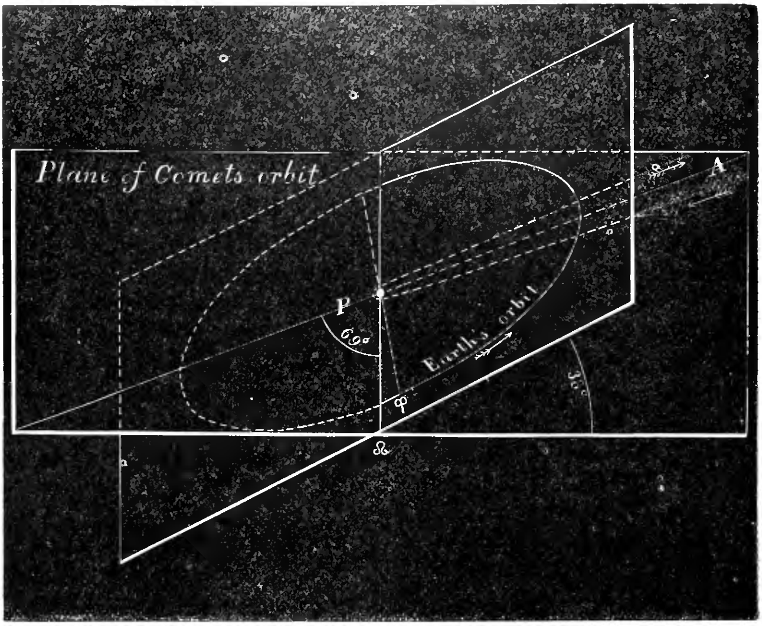


Fig. 4.

1843 and 1880 may easily be identical. Indeed, the orbit given for the latter comet corresponds to a period of almost thirty-seven years, and Meyer has shown that the observations can not be reconciled with a period less than thirty or greater than fifty years. Now, thirty-seven years would take us back just to 1843, so that it is very likely that these two comets are really one and the same. So far the "identifiers" have matters their own way. But, now, as to the comet of 1882. Can it be identical with the comet of 1880? We think not. The orbit of the latter was computed exclusively from observations taken *after* its perihelion passage, so that no action of the *sun* depending upon its close approach at perihelion can account for its return in less than three years, and the inclination of its orbit is such that ever since it went out of sight it has been out of harm's way as to perturbations by the *planets*. Then, again, the orbit of the comet of 1882 does not agree with the idea of identity. Whatever other effects may have been produced by the resistance of the solar atmosphere at perihelion, this resistance must have tended to *shorten* its period, if it changed it at all. Now, the observations thus far taken, though perhaps not sufficient to settle the orbit definitively, seem to be absolutely inconsistent with a period of anything like three years (corresponding to an eccentricity of 0·9963). The period can not well be less than ten or twelve years, according to the last results, and may be several thousand. It is to be noted, further, that, as regards ☊ and q, the two orbits differ more than can well be consistent with the theory of identity. It seems to be an almost necessary consequence that these two comets can not be identical with each other, though they may, perhaps, both be fragments of the comets of 1668 or 1843, or of some comet more ancient than either.

It is an interesting fact that Mr. Chandler finds that his orbit, computed entirely from post-perihelion observations, satisfies almost exactly the observation of Mr. Finlay, taken on September 8th, as well as the observation of the comet's disappearance at the sun's edge. If the observations of Dr. Gould, when they come to hand, agree as well, it will be proof positive that no sensible resistance or disturbance of any kind was suffered by the comet in passing within 300,000 miles of the sun's surface at the rate of 300 miles a second.

Of course, if the view we have taken is correct, there is no possibility that our comet can return in six months and fall into the sun. Not that there is any *absurdity* in the idea by itself considered. If the comet of 1880, when receding from the sun, had moved in an orbit corresponding to a three years' period, and if the present comet were found to have a period of three years or less as it is now receding from the sun, it would be almost impossible to refuse to admit their identity, and probable speedy absorption in the sun.

We close with a single word as to the probable consequences of a comet's fall upon the sun. Unquestionably, the energy of the comet's motion would be transformed into heat, and if the comet had any considerable mass, say $\frac{1}{100}$ the mass of the earth, the heat produced would be enough to supply the sun's heat-expenditure for months. Probably, however, no comet has a mass anything like so great as that; more likely the present comet even, huge as it is, has a mass less than $\frac{1}{100000}$ of the earth's, so that its collision with the sun would produce as much heat only as the sun would expend in eight hours.

Now, if the sun were a cool, solid, or even liquid mass, the sudden accession of merely this quantity of heat would undoubtedly produce an enormous rise of temperature and a great increase of radiation. But, constituted as the sun is—mainly a mass of gas and vapor—the effect would be entirely different, the energy being principally expended in producing expansion and evaporation, with comparatively little increase of temperature or radiation. If one stirs up the fire under an open kettle, the water gets no hotter—it only boils faster. Probably the effect of the fall of a body, even as large as the earth, upon the sun, would be hardly anything more than to restore the sun to the condition it was in a century ago. The energy lost in the course of a century would be replaced—that is about all. During the few moments while the body was passing through the sun's atmosphere, there might be, and probably would be, phenomena of great interest and beauty to those who were on the watch; but it is very doubtful whether people generally would know anything about the occurrence until they read of it in the papers.

SCIENTIFIC PHILANTHROPY.*

By ALFRED FOUILLEE.

THE questions relating to public relief, population, and natural selection are so inseparable that, in our age, thought has been logically conducted from one to another of them, and has been led to important discoveries. It was the problem of public relief, and the observation of the effects produced by the poor-rates, that inspired Malthus to compose his "Law of Population"; it was the law of population, in turn, that led Darwin to the discovery, first, of the law of the "struggle for existence," and afterward of that of "natural selection." We may say, then (and the fact is worthy of remark), that it was a social and economical problem that provoked one of the greatest revolutions in natural history. Even before Darwin, Mr. Spencer, by studying in his "Social Statics" the influence of philanthropy on the movement of population, upon the artificial multiplication of the feeble in body or mind, and upon the deterioration of the race, had shown how vital competition might produce, by means of selection and elimination, sometimes progress, sometimes decadence, of a species. He thus anticipated Darwin; but he did not perceive, as Darwin did, the capital fact of the divergence from the primitive type which results from natural selection among living beings, and produces the final variation of species. Nevertheless, natural science and social science have shown an intimate connection in this respect, which exists no less in all the other problems. Thus, we are not able from this point to separate these two sciences. To reduce sociology to the category of moral, economical, and political sciences is to condemn it to remain an abstraction, and to treat its problems incompletely by ignoring essential data; the legist, the economist, and the politician, who take no account of the laws of biology, are like a doctor who is not acquainted with the structure or the functions of the organs, or, to use Mr. Spencer's comparison, resemble a blacksmith who would work in iron without knowing anything of its properties. We must, therefore, approve of labors which, like those of Messrs. Spen-

* Translated for "The Popular Science Monthly," from the "Revue des Deux Mondes."

cer, De Candolle, Ribot, Galton, and Jacoby, include the study of the effects of natural selection and physiological or moral heredity in human society. Philanthropy ought not to content itself with reasons of sentiment; it should become scientific. Few questions are better adapted than that of public relief to demonstrate the necessity of this progress and the extreme complexity of social problems, in which the most various rights are involved and the laws of natural history add their force to those of political economy. What, in the Darwinian point of view, becomes of the public duty of relief? First, what is its moral foundation, misconceived by certain partisans of Malthus and Darwin, and what are its necessary limits? Secondly, are there not biological laws that intervene in a question at first sight entirely moral; and can the legislator neglect the social consequences of these natural laws? In short, has philanthropy regulated by science a salutary or an injurious influence on the movement of population, and does it produce in the race a useful or a harmful selection, progress or decay? These are the principal problems deserving a long study, to which we will at least call the attention of readers. If we only show clearly their difficulties, and vaguely forecast the solutions of them, we shall not have wasted time or trouble.

The partisans of Darwin generally adopt in social science the law of Malthus, from which Darwin himself has drawn most important consequences in natural history. Now, Malthus has conceived that by this law he could condemn absolutely that philanthropy which is practiced under the form of public benevolence. He not only denies all duty of relief on the part of the state, but also declares private charity dangerous and irreligious. Leave to Nature, he says, severely, the office of punishing the improvidence of the father who calls to life more children than he can support; Nature will not fail to perform her task, and it is a providential one. Since Nature is charged with governing and punishing, it would be a very foolish and misplaced ambition to pretend to put ourselves in her place, and take upon ourselves all the odium of execution. Then give up that guilty man to the penalty imposed by Nature. The aid and assistance of parishes should be closed against him, and, if private charity extends any help to him, the interest of humanity imperiously requires that that help shall not be too abundant. He must be made to learn that the laws of Nature, that is, the laws of God, have condemned him to a life of pain for having violated them, and that he has no kind of a right as against society to obtain from it the slightest portion of support. Can this summary condemnation of public charity, pronounced by the Malthusians and the radical Darwinians, be accepted from the point of view of morals and right, and must we inevitably maintain it from the point of view of natural history, or even of the laws laid down by Darwin?

Regarding the question of right, it seems to us that a capital distinction should be made between the present and the future, between the duty of the state toward those who are born and its duty in respect to those who may hereafter be born. There is at this moment upon the earth enough, and more than is needed, to support the men who are now living; but the time may come when there will not be enough to support all those who may have been called to life, and it is only at that time that the Malthusian law of population will become incontestable. The moralist should, then, place himself in succession at both these points of view—points between which neither the Malthusians nor the Darwinians have sufficiently distinguished.

To get a better comprehension of the question, let us begin by examining the simplest cases, after which we will consider the more complex reality. To revive an ancient and classical example, from which we may draw new consequences, let us suppose a man settled by himself on an island, on which there is not only all that he needs, but a superfluity, and that a shipwrecked man is afterward cast upon the island. Undoubtedly the first occupant is not obliged to give up that which is indispensable for his own life, but he owes the new-comer a part of his superfluity. If the island affords sufficient to support two men, the first one has no right to monopolize the whole of it. He ought, then, to surrender to the companion, whom chance has sent him, a part of the soil. By doing this he will perform not only one of the acts of benevolence discredited by the Malthusians and Darwinians, but the act will be one of strict justice. Now, let other men come upon the island; let the soil be wholly occupied, appropriated, covered with houses, and inclosed in fences; and then suppose a new shipwrecked man lands upon it. The island either can or can not support and maintain another man. In the first case, the inhabitants, unless they desire to regard the new-comer as in a state of natural war as to them and their property, must allot him a portion of ground; or, if the ground is already entirely appropriated and divided out among the inhabitants, they owe him such employment as will furnish him the means of subsistence. The obligation is incumbent not upon a particular individual among the inhabitants of the island, but upon all the individuals collectively, and it is the duty of each one to contribute according to his resources to the common obligation. Assistance is thus a guarantee and defense of property, a treaty of peace succeeding the state of war. It ceases to be an act of justice, and begins to be an act of pure charity only when the portion of the new-comers can no longer be afforded them except by depriving the first occupants of something they need. In this case it becomes necessary, in effect, to sacrifice one man to save another.

Suppose now that, instead of being brought to the island by the casualty of a storm, the new-comers have been introduced upon it by the voluntary action of particular persons; the right of these new-comers to assistance will subsist for the present, but it is clear that the mass of the inhabitants will have a right to watch over such introductions in the future and regulate the conditions under which they may be made. If the question, for example, is one of bringing children into the world in greater numbers than the island can support, the little state we are considering will not be able to assume the duty of future assistance unless the individuals on their part renounce, as John Stuart Mill has it, their right of indefinite multiplication.

It is through failure to make the preceding distinction that Malthus rejects the whole obligation of assistance, and leaves it to Nature to do justice. The penalty attached to improvidence by the laws of Nature, he asserts, falls immediately upon the guilty one, and that penalty is itself severe. But, we may ask, are not those who suffer from the improvidence of the father, contrary to this assertion, the innocent wife and children? Let them alone, Malthus persists; let God's justice take its course. These pretended laws of God, of which Malthus tries to show us the justice, are injustice itself. The English pastor had no other resource for escaping the objections of the moralists than to invoke original sin. "It appears indispensable," he says, "in the moral government of this universe, that the sins of the fathers shall be punished in the children. And if our presumptuous vanity flatters itself that it could govern better by systematically contradicting this law, I am led to believe that it will engage in a vain enterprise." Where Malthus sees an effort of human vanity, social science sees an effort of human justice, superior to the pretended justice of Nature or of Providence. To trust to natural and providential laws for the prevention or reparation of wrong is to act like beings without intelligence or will—is to accept for man the fatality that controls animals, "which, however, have not eaten of the forbidden fruit."

The argument of Malthus, adopted by many English economists, as well as by the naturalists of the Darwinian school, is contrary, not only to pure fraternity, but also to strict justice. Malthus reasons as if there were at this very time not enough food on the earth for all the men; as if in the existing state of society there were to be found no men enjoying superfluity, while there are, however, men who have nothing to live upon. Instead of limiting his assertions to the future, and to a future still far off, he speaks as if those harsh words which have been so many times cast in reproach by the socialists against the strict economists, as containing the most authentic formula of their theories, were applicable even to the present time: "A man born into a world already occupied, whose family has no means of supporting him or of whose labor society has no need, has not any right to demand any portion whatever of food. He is really one too many on the land. No cover is laid for him at the great banquet of Nature. Nature tells him to go away, and does not delay herself to put the order into execution." All is involved in that doctrine; it is in effect the right even of living that Malthus denies to a host of men. To solve the question he has recourse to Nature, which knows neither pity nor justice; he should, on the contrary, have appealed to the reason and freedom of man. In fact, it is not only at the "banquet of Nature," as Malthus asserts, that the new-comers demand a place, it is more, and above all at the banquet of humanity; they are men, and men have called them into existence: did any one consult them before giving them the light? And if their parents have brought them to life without their consent, is it not on the implied condition that they will furnish them a share of subsistence in exchange for a share of work? When a child is born into a family, it is rightly said, none of his brothers has the right to prevent his sharing in the property of their father; likewise, there are no "cadets" in a nation. If the family fails, there is still above it the great national family; a solidarity exists between all the citizens of the same country. It is by reason of this that you, legislators, unable to establish a law to regulate the multiplication of the species, have implicitly accepted certain charges in regard to the children who are born, in the event of the failure of their natural fathers and mothers. Such children are neither "usurpers" nor "intruders," for they are not themselves responsible for their birth, and you have no right to say whether you will accept or reject them, for there is actually enough of subsistence for all. The Darwinians will presently show us the necessity of society taking precautions for the future, but the present charge, nevertheless, exists, and we must execute it. In the existing society the capital is not lacking, but all the men have not their share; this state of affairs, the inevitable effect of economical laws, creates in the laborers a condition of inferiority and servitude. Here, then, is a place for the intervention of reparative justice in the form of public assistance. Is the man who, in the midst of a dearth, refuses to sell his corn, or who buys a large quantity of corn to take it out of the market, exercising his right? He might, perhaps, claim that he was the legitimate proprietor of the product of his fields or of his purchases. But the identical principle on which property is founded—that is, the right to work for a living—limits it by the equal right of another. Society has not hesitated to impose restrictions and obligations as to many points on proprietors who assume to be "absolute"; it prevents them from blocking the course of circulation; it expropriates for causes of public use; it punishes the man who burns his goods; it can exact an indemnity from the one who lets his property go to waste. As a rule, no right relative to exterior objects can be absolute; there is always a place for reciprocal limitations, and consequently for conventions and compromises. Respect for already existing properties, and for the established order, can not, in strict right, be exacted from the new-comer unless some means of existence are reserved for him. Here is a relation of contract, a tacit convention: I agree to respect your means of living, on condition that you respect mine; I consent to respect your right to live, on condition that I do not see mine destroyed. There is then a stipulative relation which establishes at the same time the foundation and the limit of the right of property, on the one side, and of the right to live on the other. The first is not more absolute than the second, but we can not ignore the one without injuring the other.

We can not, however, from the fact that the philanthropic duty of assistance may not be unlimited and unconditional, conclude with Malthus and the naturalists of his school that the duty does not exist. If such a conclusion were logical, we should have to apply it to all real rights, for there is not one of them that is absolute and without limits; not the right of property any more than the others. The only legitimate conclusion is, that it is necessary to confine assistance within certain boundaries, to restrict it by the consideration of other rights, to submit it to conditions, and consequently to make it the object of a contract, and thus to realize on this point as on all the others the ideal of stipulative justice. The practical limitation of a right is always by another right: the right of property, for example, is limited by the right of circulation, by that of condemning it for public uses, etc., and *vice versa;* and the means of fixing the limit is free parleying between the parties, resulting in a contract. All legislation which neglects to give a form of contract to the laws it promulgates, prepares conflicts of every kind for society, and leaves a germ of war in the law itself.

But, while true philanthropy, which has to do only with social justice, ought to consider the present and the past, it has also to deal with the future. It is in this point of view that the theories of Malthus and Darwin gain the advantage; here moral and juridical considerations are complemented by considerations borrowed from natural history. We have already recognized, with Malthus and Stuart Mill, that we can not put this point aside unless we would produce artificially, in a more or less distant future, an excessive multiplication of the species. It now remains to examine, with Mr. Spencer and Mr. Darwin, another rock in the way of the philanthropist—the danger of producing a physical and intellectual deterioration of the species by overlooking the laws of natural selection and heredity.

Philanthropy, apart from science, sees only the immediate influence of the measures it proposes; it entirely neglects their influence, infinitely more important, on the physical status and the morals of future generations. It forgets that every new measure in legislation or policy tends to produce modifications, for better or worse, in human nature.* These modifications are the inevitable effect of biological laws,

* Religious fanaticism, for instance, by its measures of persecution, has produced effects which its partisans were far from foreseeing, and a kind of cross-action. "By a course of penalties and poisonings," says Galton, in his "Hereditary Genius," "the Spanish nation has been deprived of free-thinkers and drained, as it were, of a thousand persons a year, during the three centuries between 1474 and 1784; for an average of one hundred persons were executed and an average of nine hundred persons imprisoned every year during that period. During the three centuries, 32,000 persons were burned, 17,000 burned in effigy (the most of the persons themselves died in prison, or left Spain), and

that is, of the struggle for existence, heredity, and natural selection. A benevolence that takes no account of those laws may become malign, and the short-sighted fraternity that considers only the existing generation may be transformed, as we shall see, into a veritable injustice toward future generations. The great danger to which a blind charity, dissociated from science and stipulative justice, exposes itself is that of depressing the physical and moral level of the race. What are the conclusions of Darwinism on this point? We may, with Mr. Spencer, summarize them in the two propositions which every philanthropist, in his opinion, should have always present in his mind: "The quality of a society is physically lowered by the artificial preservation of its feeblest members; the quality of a society is lowered morally and intellectually by the artificial preservation of those who are least able to take care of themselves." Let us successively consider, and endeavor to restrict to their real bearing, these two capital propositions. The law of Malthus, from which Darwin has deduced the law of the struggle for existence, tends to produce in the existing state of society a numerical surplus of individuals who struggle for life itself. Excessive fecundity has good and bad results. All individuals finding themselves subjected by its operation to an increasing difficulty in gaining their living, there is produced in society a kind of pressure, the natural effect of which is, on the average, a progress. Those alone, in effect, can survive who are capable of resisting that pressure, and even of advancing under its influence; these, then, may be considered "the elect of their generation." When an individual succumbs, it is always for lack of power to triumph over some action of the environment—cold, heat, moisture, insalubrity of air, etc. He can not make way against one or many of the numerous forces that act upon him, and in the presence of which his vital activity is called upon to display itself. He may succumb to them more or less quickly, according to the vigor of his organization and the incidents of his career; but, in the natural course of events, those who are imperfectly organized pass away before having any offspring, and only the most vigorous organizations contribute to the production of the succeeding generation. Such is the natural selection, favorable to the improvement of the species, which is produced in mankind when Nature is allowed to act without contradiction. It is, says Mr. Spencer, a natural work of elimination by which society is continually purifying itself. Suppose now that a

291,000 were condemned to prison and other penalties. It is impossible for a nation to endure such a policy without suffering a great deterioration of the race. The taking from the nation its most intelligent and most vigorous men had for its most noteworthy result the formation of the unintelligent and superstitious race of contemporary Spaniards." Attention has frequently been called to the disastrous effect of the military *régime* of our epoch, which deprives the family and labor of the soundest part of youth, and, leaving at home only the weak or sickly men, produces a selection backward in the nation. When war is added to universal armament, it harvests the best part of a people, and debases the generations which follow it.

philanthropy ignorant of social science and of the natural sciences undertakes to correct Nature, to diminish at any price the chances of mortality of the weak, to cause them by means of its care and its assistance to survive artificially, what will be the results for future generations? At first, population will increase more than it would have done; every one will then find himself subjected to a greater difficulty in living, and exposed to destructive actions of the most intense character. This increase of population might still produce good results if it were not due to an increase in the number of the weak. But the survival of the weak spoils all; they marry with the strong, who under other conditions would alone have survived; such marriages change the general constitution of the race, and cause it to come down to a lesser degree of force, and what we might call tonicity, corresponding with the conditions of existence that have been artificially created. Such an instrument, whose cords are relaxed, no longer gives to strong or harmonious sounds as of old. An effeminacy of the species is produced, and it has become at the same time a little more numerous and a little weaker. In preserving the less vitalized part of the present generation, we have prepared for the decadence of coming generations.

This decadence is brought about also by other causes. Your philanthropy, say the Darwinians, suppresses or attenuates some noxious influences, and this gives delicate constitutions more chances of surviving and propagating themselves; but you do not perceive that, in place of the unfavorable influences suppressed by you, you cause new destructive ones to arise. "Let the average vitality," says Mr. Spencer, "be diminished by more effectively guarding the weak against adverse conditions, and inevitably there come fresh diseases," for the increase of diseases is the correlative of diminished vitality. Look at the numerous diseases unknown among barbarians from which civilized races suffer. Diseases of the brain, especially, seem to increase with civilization; the proportion of them to the whole population appears to have doubled in France since 1836. The activity which is stamped upon industry, the arts and the sciences, political and social agitation, the fever of money-making, and the consuming life of cities are engendering in civilized nations a condition of cerebral agitation resembling intoxication, which must predispose to intellectual troubles. We may add that the necessity of supporting the weak and non-producers, as Mr. Spencer says, imposes an additional excess of burden on the producers; the weariness of the latter increases till it becomes a cause of sickness and premature death, and the mortality which has been evaded in one shape must come round in another; and, finally, it is the inferiorly endowed who survive and the best endowed who perish. If this misguided fraternity is perpetuated, it will end, according to the Darwinians, by changing a vigorous and youthful society into a prematurely aged society. Suppose a whole nation composed of old men: old age differs from youth and the age of maturity in being less active in production and less capable of resistance to destructive influences; men feeble in constitution, while they are still young, are in an analogous position. A society of enfeebled persons would, then, lead the kind of life that a society composed of old men, with no one to wait upon them, would lead. The resemblance becomes complete in the fact that in both groups life lacks the energy that renders labor easy and pleasure keen. The old man sees the causes that give him suffering increase and those that give him pleasure diminish, for physical exercise is the condition and the accompaniment of most pleasures. Thus is produced a languishing, monotonous, and dreary life. Finally, says Mr. Spencer, when the average type of the constitutions among any people has fallen to a certain level of vigor inferior to that which can without difficulty resist the ordinary strains, and perturbations, and dangers, mortality is still not diminished, and, on the other hand, life, ceasing to be an enjoyment, becomes a burden.

Such are the views of the Darwinians upon the physical deterioration of races by the operation of a mistaken philanthropy. These considerations show well that moralists, economists, legislators, and statesmen ought to come out from the traditional routine to study, in the light of the laws of contemporary biology and sociology, what will be the effects in the future of the measures they recommend or adopt. Nevertheless, we should beware of exaggerating the bearing and consequences of the theorem we have just postulated. There are distinctions to be made, and those who share the views of Darwin do not always make them. Let us first leave out of the account the really sick, who are taken care of at home, or in the hospitals. Diseases are, as a rule, generally accidental, except when they result from an original constitutional defect or from some willful excess. Evidently we are not rendering a bad service to society when we take care of workmen who have been afflicted with sickness or are the victims of some accident. Suppose the wife of a vigorous and efficient workman falls sick; if the workman is very poor and no one comes to his assistance, he will be obliged to overtax and exhaust himself to take care of her; and that would be a loss to the whole community. His children, of good constitutions, who would have lived if the mother had been assisted, will become ill or die if the family is reduced to want. Is it necessary to let those whom disease attacks die without pity, as armies are sometimes forced to abandon those who fall on the road? No Darwinian will in good faith maintain that. The theorem of Darwin can apply, then, only to the infirm properly so called, to whom philanthropy is accustomed to give assistance, as well as to men attacked with accidental diseases. We may, however, here first call attention to the fact that the infirm inmates of hospitals and those who are succored at home are a small part of the nation; and it is no great inconvenience to the sound to take care of them. Moreover, the infirm in the hospitals hardly ever contract marriage ; so that we need not fear much from their posterity. Furthermore, we might, if it should become necessary, impose conditions and even legal restraints upon their marriage. The same is the case with the infirm who are assisted at home ; if they have any important physical infirmity, they seldom think of marrying, and are hardly ever able to marry. The Darwinian theorem, moreover, proves too much, for it is applicable not only to the weak in body, whom philanthropy takes under its protection ; to be logically carried out, it should be taken home to each family, and insist that no deformed or weakly child deserves to live. We should say no more, " Woe to the conquered ! " but " Woe to the weak ! " In effect, when a father and mother preserve the life of their child only by the exercise of the greatest care, when a doctor employs all his skill upon it, that fatherly and motherly care, that medical skill, will only have succeeded in preparing " artificially for society a member without vigor " ; and the latter, in his turn, by marrying, will put into the world children still less vigorous. The Spartan method of disposing of feeble children will then become that of the perfected sociology. We shall test men as we now test our guns, throwing away those which can not support a certain pressure. The struggle of art against the natural elimination of the least vigorous is carried on in the bosom of the family rather than in the hospitals. Public philanthropy does not, therefore, appear to be responsible for the principal inconveniences it brings ; it is parental love that we have to deal with, and, since that love is infinitely more advantageous than inconvenient to society, it is our duty to brighten, not to obscure it.

It is rather before marriage than after the birth of children that the real problem presents itself, and philanthropy should be exercised in the interest of humanity itself. There is a moral question here, and it is for the moralist to instruct the weak, delicate, or sickly person, concerning the grave responsibility he assumes in contracting marriage and running the danger of entailing upon his children the evils from which he is suffering. Man, says Darwin, scans with scrupulous care the character and pedigree of his horses, his cattle, and his dogs before matching them, but never takes such a precaution when the question is one of his own marriage. It is certain that the person who calls another being into life is not the only one concerned in the matter, and that, if he has a good supply of physical evils in himself, he ought to hesitate before condemning his posterity to them. But must we go further, and make a social and judicial question of the moral one ? Ought the state, the natural protector of the rights of third parties, to intervene here in the physical interest of the children and of the nation, as it interferes for their moral interests and even in questions of mere future ? Darwin and his partisans, M. Ribot, for instance, are inclined to have the state intervene now, or as soon as custom shall have prepared the way for its intervention. When, says

Darwin, we shall have come to a better comprehension of biological principles, of the laws of reproduction and heredity, for example, we shall no longer hear ignorant legislators repelling with scorn a plan for ascertaining whether or not consanguineous marriages are injurious to the species. According to Darwin, persons of both sexes should be prohibited from marrying when they are found to be in too marked a degree inferior in body or mind. The same rule would apply to those who will not be able to save their children from abject poverty ; for poverty is not only a great evil in itself, it also tends to grow by promoting indifference in marriage. M. Ribot expresses the just hope that custom will eventually take account of the data of science in this grave question, but he also contemplates the ultimate intervention of the law. This is, in our view, a dangerous means. In aspiring to favor well-assorted marriages in a physical respect, the law would, in the first place, favor licentiousness and the birth of illegitimate children. Now, licentiousness and the temporary union of the sexes unaccompanied by forethought and determined responsibilities, would encumber society with good-for-nothings to a much greater extent than the marriage of weakly beings. In the second place, the intervention of the law might impose hindrances, to a much greater extent than that of parents, to morally and intellectually well-assorted marriages as well as to congenial ones. Finally, governments are still less infallible than parents in the matter of making a decision concerning the future of children. All that could be done would be to exact from those wishing to marry some assurance that they have the means of living, and will be able to take care of their children. It would still be necessary, we repeat, to prevent such a policy operating, as it does in Germany, as a promoter of illegitimate births. This question is not, however, in reality, within the province of philanthropy properly so called, with which we are particularly occupied. Philanthropy can be charged here only with the assistance which it gives the feeble-bodied for the prolongation of their existence, and for the means it affords them for bringing into the world still feebler children. The Darwinians exaggerate the harm caused by philanthropy in this respect ; for they forget that it can not wholly transform nature. Its power is limited to prolonging the life of an individual (which is no great harm), or to prolonging his race for a time that is more or less brief. One of two things must be the case : either the evil relieved by philanthropy is a fatal germ of decay and death for the posterity of the assisted man, in which event the benevolence will only delay without preventing the inevitable extinction of that posterity ; or, on the contrary, the evil is reparable and posterity may recruit, strengthen, and perfect itself—that is, may cross over the mountain instead of falling back upon it. Must we in the latter case reproach Philanthropy for having held out the hand of relief to those who were about to fall for ever ? This dilemma can be resolved only in each particular instance as it occurs ; what right have we, then, to prejudge the solution, and that in favor of the cruelest sentiments? We shall shortly see that the inconveniences, when they exist, are compensated by the advantages. The logical conclusion is that, if the moralist ought not to be too much occupied with these complex problems, so the legislator can not be too prudent when he is thinking about intervening, for his intervention will be much more artificial, and may be more dangerous, than the intervention of philanthropy.*

Let us now pass from the influence which philanthropy can exercise directly upon individuals to that which it can exercise upon the environment, by making it more favorable to the weak and wretched. There is here an important distinction which the Darwinians too often neglect to make. Among the conditions of the environment, of hygiene and of health, which can be managed for the whole of a population, we should designate first the normal conditions which tend to assure the normal development or performance of the organs, such as pure air, nutritious and sufficient food, proper clothing, healthy houses, the adjustment of the work to the strength, etc. A philanthropy which endeavors to realize these conditions for the largest possible number of men is evidently acting in the same direction with nature; far from enfeebling the generations, it is fortifying them. It would be a sophism to assume that we could fortify the generations any better by habituating them to do without these favorable conditions, for we can not do without necessaries; the budget of nature and life is fixed, and can not be varied except within narrow limits. What would we say of a father who, to exercise the nutritive functions of his children, should try to habituate them to living without eating, who to exercise their lungs should place them in a vitiated atmosphere, who to exercise their sense of sight should make them work and read in an unlighted room? That would be to propose a problem as insoluble as that of making a fish live without water. In fact, populations subjected to unhealthy influences become wretched and sickly; their children fail to grow; they are thin-blooded, feeble, small, thin, and tainted with such diseases as goitre, pellagra, ophthalmia, and cretinism. We can not add to the strength of men by making them live in unhealthy districts instead of healthy ones. Excessive labor likewise exhausts the minds and bodies of generations as it does of individuals. Doubtless the strongest will survive, but they will survive enfeebled, and, although relatively strong, they will have really

* The fact is furthermore established by statistics that, notwithstanding the increased propagation of the weak in civilized societies under the influence of philanthropic feelings, and notwithstanding the increase of population, the length of life is now greater than formerly. This proves that the decrease of some causes of mortality has been greater down to the present time than the increase of other causes. Furthermore, the debility of the existing generations may be a result of the stimulus which has been given to industry under conditions which are still very defective, and which will be improved in the future.

become weak; they are the one-eyed among the blind. We shall thus have obtained a survival of the weak, who will beget weak offspring. The argument of the Darwinians may then be turned back upon them, and we may propose on our side the following theorem: To realize the normal conditions most favorable to mankind is to assume the development and selection of a majority of the strong while saving only a minority of the weak; for to be sick is the exception when the conditions as to hygiene and food are at the best.

The reasoning of Mr. Spencer, repeated by M. de Candolle, is, in our view, valid only under abnormal conditions. If we bring up children effeminately, in mental and physical idleness, if we feed them on candies instead of bread and meat, if we keep them in a greenhouse and out of the open air, if we do not let them take any exercise for fear they will be tired, we shall evidently debase them, and prepare, through them, for the debasement of the race itself. In short, the causes for the deterioration of a generation are luxury, effeminacy, and idleness. There is nothing strange from this point of view in Dr. Jacoby's demonstration, that extinction is the ultimate fate awaiting every royal and aristocratic family, that it has come or will come upon the Cæsars, the Medicis, the Valois, the Bourbons, our French nobility, the Venetian aristocracy, and the English lords; for it is in such families that the causes of decay, inseparable from power and riches, produce their fatal results. Sterility, mental disorders, premature death, and the ultimate extinction of the race, do not constitute a future reserved particularly and exclusively for sovereign dynasties; all the privileged classes, all families occupying exclusively elevated positions, share the lot of reigning families, although to a lesser degree, which degree is always in proportion to the grandeur of their privileges and the altitude of their social state. But if we grant this principle for once, we may still ask the pessimist disciples of Darwin if philanthropy is in the habit of assuring to the needy the luxury and the soft life of aristocracies. It at least, one may say, permits idleness; but that is the fault of those who come to the assistance of the suffering workingmen, for it is their right and duty to require an equivalent in labor for the assistance they give.

We have as yet examined only the first of the Darwinian theorems relative to the effects of misapplied philanthropy: a society may deteriorate in a physical respect by the artificial preservation of the weakest, if it does not conform to the real course of nature. The Darwinians add to this that it will also deteriorate in a moral respect, by the artificial preservation of the individuals "least capable of taking care of themselves." The principle on which this new theorem is based is that the laws of heredity and selection are applicable to the moral as well as to the physical side. We admit that Messrs. Galton, Ribot, and Jacoby have undoubtedly established this principle. Moral vices, like physical vices, end, after they have been for a long time implanted in families or races, by transmitting themselves from generation to generation. Darwin insists much on the transmission of that moral quality which he calls character, strength of will, courage, self-reliance; on the other hand, there are also, according to him, people trifling, idle, and careless by right of birth, like the Irish. Transport to the same country an equal number of Scotch and Irish, says Darwin: at the end of a certain time the Irish will have become ten times as numerous as the Scotch, but the latter, by virtue of their hereditary qualities, will be at the head and occupying the highest places. "If any one denies," says Mr. Spencer, "that children bear likenesses to their progenitors in character and capacity, if he holds that men whose parents and grandparents were habitual criminals, have tendencies as good as those of men whose parents and grandparents were industrious and upright, he may consistently hold that it matters not from what families in a society the successive generations descend. He may think it just as well if the most active, and capable, and prudent, and conscientious people die without issue; while many children are left by the reckless and dishonest. But whoever does not espouse so insane a proposition, must admit that social arrangements which retard the multiplication of the mentally-best, and facilitate the multiplication of the mentally-worst, must be extremely injurious." Help the least meritorious to propagate themselves by enfranchising them from the mortality to which their absence of merit devotes them, and merit itself will become more and more rare from generation to generation. Furthermore, besides seeing to their own preservation and that of their families, the good will be obliged also to look to the preservation of the bad and their families, and will be thus in danger of being overtaxed. This is what Stuart Mill also complains of. In consequence of the unintelligent use of the income-tax, and the obligation of every parish to support its poor, the workers are compelled to take care of the idle. Is this justice? In some cases, this situation prevents the industrious from marrying; in others, it limits the number of their children, or prevents their giving them a sufficient support; in others, it takes industrious men from their families; in every way it tends to arrest the propagation of the capable, to injure their constitution, and to bring them down to the level of the incapable. During this time the latter will increase and multiply, conformably to the misinterpreted wisdom of the Bible; they will swarm at the expense of others. This, says Mr. Spencer, is a deliberate storing-up of miseries for future generations. We can not make a worse present to posterity than to encumber it with a continually increasing number of imbeciles and criminals. To aid the bad in multiplying is, in effect, the same as maliciously providing for our descendants a multitude of enemies. We have a right to ask if the maudlin philanthropy which thinks only of ameliorating the evils of the moment and persists in overlooking indirect mischiefs does not produce a greater total of misery than extreme selfishness?

Such are the objections of Mr. Spencer and Mr. Darwin in all their force. In our opinion, they still bear against the blind and irrational exercise of philanthropy, rather than against philanthropy itself. Pushed too far, the theorem relative to the moral and intellectual debasement of societies would have consequences still more inadmissible than that relative to their physical debasement. In fact, the law of mental and moral heredity, which is their principle, is much more vague and loose than the law of physical heredity. What is the meaning of the unprecise expression, "a society lowered by the artificial preservation of the individuals least capable of taking care of themselves"? Does Mr. Spencer mean that parents in the habit, for example, of soliciting at the charitable institutions will beget children endowed with the innate disposition to go to the same institutions? England certainly offers a spectacle of this kind of poor, who are assisted from father to son by the parishes; they are, we might say, the lords of beggardom; in them hereditary indigence is raised to the dignity of an institution. Poor mothers surround themselves with their numerous children as so many titles to assistance—they are Cornelias of a new race. But whose fault is it? Is it not that of the distributors of the poor-taxes, which are, moreover, increasing every day under this system? Is it not, furthermore, the fault of the bad education received by the children, rather than of heredity of temperament? If these children were brought up with the children of a lord, would they exhibit an innate propensity to beg or to be assisted by others? We believe, generally, that Messrs. Spencer and Darwin, as well as Messrs. Jacoby and Ribot, attribute too great a part to heredity, too little a one to education and circumstances.

The part played by the social and political organization in England must, moreover, not be forgotten. In France, by the operation of the rule of equality, there are between four and five million proprietors, and the increase of population is so slow as to give uneasiness to those who regard the material and military power of a nation before everything else. In England, the soil is owned by thirty thousand persons, and half of it is in the hands of a hundred and fifty large proprietors. In consequence of this feudal monopoly and this rule of inequality (for which many of our contemporary writers utter Platonic regrets), neither the workmen nor the villagers can live without the aid of the poor-taxes. The lords having arrogated to themselves the monopoly of wealth, a part of the nation would be reduced to the most extreme wretchedness if they did not deign to compensate for their injustice with their charity. We must admit that they come within a certain distance of reaching this point, for the number of assisted has diminished one half during the last thirty years. In the greater part of England the wages of the agricultural laborer vary between six and twelve shillings a week; his lodging costs him one shilling a week; it is impossible for him to live on the remainder of his wages with a wife and only two children. Now, by the zeal of biblical preachers, and the traditional improvidence of the fathers, they have on the average eight children, sometimes fourteen or sixteen. The result is that they can not dispense with assistance, either public or private. Not a day-laborer in the field, says Mrs. Grote, lives or supports his family with his wages alone; he subsists partly upon his savings and partly on alms. Having no hope of becoming a proprietor, like the French peasant, the English rustic is prodigal and exacting in the matter of the comfortable; and, as his fecundity realizes the ideal of the Old Testament, his improvidence realizes that of the New. The fecundity and improvidence of the workmen in the factories are still greater.

Gold may be thrown out by the handful in vain; it is impossible to fill this sort of a cask of the Danaïdes; pure charity, while it may relieve the suffering, is incompetent to suppress the causes of misery and supply justice. Neither can religion replace science. There is one thing, says Mr. Spencer, which calls for especially severe reprobation; it is the waste of money inspired by a false interpretation of the well-known maxim, "Charity covers a multitude of sins." "For in the many whom this interpretation leads to believe that by large donations they can compound for evil deeds, we may trace an element of positive baseness—an effort to get a good place in another world, no matter at what injury to fellow-creatures."

But, we ask, does Mr. Spencer see where the evil and the remedy really are when he attributes the carelessness and the idleness of the poor to heredity, and is especially concerned to prevent the transmission of these vices by the blood to future generations? The best processes of Darwinian selection would be without important results in the absence of good education, and education would itself have little power in the absence of just laws. These two essential elements which the Darwinians have overlooked—education and laws—must, then, be reinstated in the problem.

[*To be continued.*]

TRACES OF A PRE-INDIAN PEOPLE.

By CHARLES C. ABBOTT, M. D.

BY the cautious archæologist all evidences of ancient man in Eastern North America—exclusive of true palæolithic implements—are wisely referred to those Indian tribes that, to within a comparatively recent period, were the sole occupants of the territory named. Perhaps, however, the time has come when it may be asked if all the traces of prehistoric man, gathered along our northern Atlantic seaboard, are of one origin. In other words, have traces of a people later than American palæolithic man, and earlier than the Indian, been discovered?

When we chance upon a stone arrow-point lying in the soil, it is a very different object to the archæologist than the same specimen would be lying in a cabinet. In the latter case, it is an example of man's primitive handiwork merely; in the former, it is not only the production of a skilled worker in flint, but evidence that on the spot where found man once tarried, if he did not dwell there, and that for him a necessity for weapons existed. Further, if but a single specimen be found, we may conclude that it is the point of some arrow vainly shot, or the head of a lance that has been broken and lost. But if, on the other hand, instead of one, we find a hundred scattered over a few square rods of ground, then we have evidence not simply that arrow and spear heads may be of various shapes and sizes, but that where they occur was once a village, it may be, or a battle has been fought at this point, or possibly that here an arrow-maker once plied his calling, the more definite decision being reached whether we find pottery and domestic implements also, or weapons only, or mingled with a multitude of the flakes of such mineral as that of which the weapons are made. Thus it will be seen that the practical results of an archæologist's labors are to be derived from field-work only, not from simple closet studies. He must seek out these hidden village sites, dig in their weed-grown corn-fields, and invade their cemeteries, if he would learn where they lived, where and how they toiled, and finally where and in what manner they were laid to rest.

Of a series of nearly twenty-five thousand implements and weapons of stone gathered from one limited locality by the writer, more than four fifths have been placed together in a public museum. In looking at them collectively, perhaps the most noticeable feature is that of the marked difference in finish and material. Of the chipped objects, such as arrow-heads, one instinctively separates them into finely wrought objects of jasper and quartz, and ruder specimens made of a slate-like rock.

The question is simply, Has this feature any ethnological significance? It is the purpose of this essay to determine this.

The bare fact that one arrow-head is roughly fashioned and another beautifully wrought has no significance beyond the fact that there were skillful and clumsy workmen in every tribe—professionals and amateurs. On a closer examination a fact becomes apparent, however, that should be critically regarded, and this is that the rudely made objects are almost wholly made of the same mineral, while the finely finished objects are of one of three closely allied minerals. The exceptions are too few to have any bearing on the question. Chipped implements of Indian origin, such as occur in every nook and corner of the Atlantic coast States, are made of flint in some one of its many forms, as jasper, chert, chalcedony, agate, horn-stone, or they are of quartz. I do not deny that they are also of other materials, but that more than ninety-nine hundredths are of this material—flint. In the valley of the Delaware River there are found, also, enormous numbers of similar objects, of quite uniform pattern and rudely finished, made of a mineral characteristic of the locality—argillite. This term, "argillite," as employed by Professor M. E. Wadsworth, of Cambridge, Massachusetts, to whom specimens of implements were submitted for examination, is used to designate all argillaceous rocks in which the argillaceous material is the predominant characteristic ; slate, or clay-slate, clay-stone, etc., are simply varieties of it, the term "slate" being only rightfully used when slaty cleavage is developed. The argillite out of which these specimens were made has no trace of cleavage.

The question may now very pertinently be asked, Why may not the Indians have used both minerals, flint and argillite, the one as frequently as the other?

There are no reasons why, indeed, they might not have done so ; but, on the other hand, evidences that they did not are not wanting, if the circumstances under which the objects are found have been rightly interpreted.

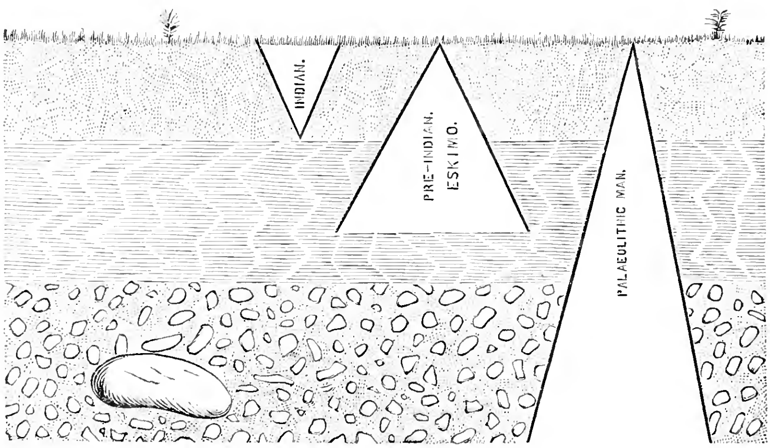
The celebrated Swedish naturalist, Peter Kalm, traveled throughout Central and Southern New Jersey in 1748–'50, and in his description of the country remarks : * "We find great woods here, but, when the trees in them have stood a hundred and fifty or a hundred and eighty years, they are either rotting within, or losing their crown, or their wood becomes quite soft, or their roots are no longer able to draw in sufficient nourishment, or they die from some other cause. Therefore when storms blow, which sometimes happens here, the trees are broke off either just above the root or in the middle or at the summit. Several trees are likewise torn out with their roots by the power of the winds. . . . In this manner the old trees die away continually, and are succeeded by a younger generation. Those which are thrown down lie on the ground and putrefy, sooner or later, and by that means increase *the black soil*, into which the leaves are likewise finally changed, which drop abundantly in autumn, are blown about by the winds for some time, but are heaped up and lie on both sides of the trees which are fallen down. It requires several years before a tree is entirely reduced to dust."

This quotation from Kalm has a direct bearing on that which follows. It is clear how, to a great extent, the surface-soil was formed during the occupancy of the country by the Indians. The entire area of the State was covered with a dense forest, which, century after century, was increasing the *black soil* to which Kalm refers. If, now,

* "Travels into North America," by Peter Kalm (English translation), London, 1771, vol. ii, p. 18.

an opportunity offers to examine a section of virgin soil and underlying strata, as occasionally happens on the bluffs facing the river, the limit in depth of this black soil may be approximately determined. Microscopical examination of it enables one to determine the depth more accurately.

An average, derived from several such sections, leads me to infer that the depth is not over one foot, and the proportion of vegetable matter increases as the surface is approached. Of this depth of superficial soil probably not over one half has been derived from decomposition of vegetable growths. Indeed, experiment would indicate that the rotting of tree-roots yields no appreciable amount of matter. While no positive data are determinable in this matter, beyond the naked fact that rotting trees increase the bulk of top-soil, one archæological fact we do derive, which is, that the *flint implements* known as Indian relics belong to this superficial or "black soil," as Kahn terms it. Abundantly are they found near the surface; more sparingly the deeper we go; while below the base of this deposit of soil, at an average depth of about two feet, the *argillite* implements occur in greatest abundance. The accompanying diagram more clearly sets



forth the conclusions at which I have arrived, after years of careful study of this subject. By this it will be seen that, as the depth *increases*, the number of ordinary flint implements of Indian origin *decreases;* and that the reverse is true of the palæolithic implements which are a feature of the gravel-beds; and is true of that intermediate form which is characteristic of the stratum of sand capping the gravels and blending insensibly with the surface-soil. This intermediate form, which is always made of argillite, is both in workmanship and design a marked advance over the palæolithic implements, and yet is so uniform in pattern and so inferior in finish, when compared with the average flint implement of the Indian, that it has been assigned to an earlier date than the latter, and considered the handiwork rather of the descendants of palæolithic man.

What is held to be convincing evidence of this has already been given in the statement of the relative positions of the two forms—Indian and pre-Indian—as seen in sections of undisturbed or virgin soil.

Negative evidence of the soundness of this view is had in the character of the sites of arrow-makers' open-air workshops, or those spots whereon the professional chipper of flint pursued his calling.

In the locality where the writer has pursued his studies several such sites have been discovered and carefully examined.* In no one of these workshop sites has there been found any trace of argillite mingled with the flint-chips that form the characteristic feature of such spots. On the other hand, no similar sites have been discovered, to my knowledge, where argillite was used exclusively. The absence of this mineral can not be explained on the ground that it was difficult to procure, for such is not the case. It constitutes, in fact, a large percentage of the pebbles and bowlders of the drift, from which the Indians gathered their jasper and quartz pebbles for working into implements and weapons.

If the absence of argillite from such heaps of selected stones is explained by the assertion that the Indians had recognized the superiority of jasper, then the belief that argillite was used prior to jasper receives tacit assent. If, however, it was the earlier *Indians* who used argillite, and gradually discarded it for the various forms of flint, then we ought to find workshop sites older than the time of *flint* chipping, and others where the two minerals are associated. This, as has been stated, has not been done. Negative evidence this, it is admitted, but, when considered in addition to the positive evidence of position in undisturbed soil, it has a value that must not be overlooked. Sufficient positive evidence to clear away *all doubt* of the presence of an earlier people than the Indian on the Atlantic sea-board of America will probably never be forthcoming, yet, to the minds of candid inquirers, there is a degree of probability in the interpretation of known facts that closely hugs the bounds of certainty.

Wholly convinced that valid reasons have been given for assuming that the chipped stone implements made of argillite are older than the similar patterns of weapons made by the Indians, it is desirable to determine whether these ruder objects are the handiwork of the ancestors of the Indians of historic times, or that of the descendants of palæolithic man, and therefore the relics of a preceding, prehistoric race.

A forcible objection that has been urged against the assumption, as it was held to be, of a pre-Indian occupancy of our sea-coast, is the difficulty of realizing that a people sufficiently advanced to make so

* "Primitive Industry," chapter xxxi, p. 453, Salem, Massachusetts, 1881.

well-designed a weapon as the argillite spear-head should not have utilized stone in various other ways to meet their wants, precisely as the Indian did subsequently. No other form of implement than these spear-heads was clearly associated with them, except when found on the surface, and so not clearly separable from the true Indian implements associated therewith. Recently, the occurrence of a stone hammer, traces of fire—charcoal—and a flat stone bearing marks of a hammer or rubbing-stone, at a depth of nearly three feet below the surface, has rendered it quite probable that a proportion of the surface-formed relics of these patterns should be regarded as of other than Indian origin. If we examine a series of the stone implements of the only other American race—the Esquimaux—we will find that not only is the variation in pattern very considerable, but that precisely such forms of domestic implements as are now in use in the Arctic regions, among the Chukches, are common "relics" in New Jersey. In his recent volume of Arctic explorations, Professor Nordenskiöld describes a series of stone hammers and a stone anvil, which are used together for crushing bones.* Every considerable collection of stone implements gathered along our sea-board, anywhere from Maine to Maryland, contains numbers of identical objects.

While many of these hammers and mortars are unquestionably of Indian origin, no valid reason can be urged that a proportion of them are not of the same origin as the argillite spear-heads. Indeed, grooved stone hammers have been found quite deeply imbedded in the sand—as deep as the usual depth at which argillite arrow-points occur; but this, of itself, is scarcely significant. So unstable is the surface of the earth, where sand prevails, that the actual position, when found, of any single specimen, is of little importance. It is only when thousands have been gathered with great care, and under the most favorable circumstances, that any inferences may be drawn. This is true of the argillite arrow-heads, of which thousands have been gathered, and presumably true of the hammers and mortars, because such implements are common among an American race which uses also such spear-points as are so abundant in New Jersey. The similarity between a Chukche spear-point figured by Nordenskiöld † and an Esquimau spear figured by Lubbock ‡ and the New Jersey specimens is very striking. Of course, such similarity may be considered as mere coincidence, but that it has an important bearing on the question becomes evident when the many circumstances suggestive of a pre-Indian race on the Atlantic sea-board are collectively considered. Singly, any fact may be held to be of little or no value; but when many of like significance are gathered together, they are self-supporting, and the one central fact becomes established.

Basing the supposition that palæolithic man was not the ancestor

* "Voyage of the Vega," New York, 1882, p. 483. † Ibid., p. 571.

‡ "Prehistoric Times," second edition, London, 1868, p. 493, Fig. 218.

of the American Indian, because there is evidence warranting the belief that "the Indian was a late comer upon the extreme eastern border of North America—indeed, the oldest distribution of the American races does not antedate the tenth century," and therefore "the appearance of the Skrælling (Esquimau) in the Sagas, instead of the Indian, is precisely what the truth required" *—basing the supposition thereupon, it was suggested † that in the Esquimaux we should find the descendants of that oldest of all mankind—*homo palæolithicus.*

Having given the strictly archæological reasons for dissociating certain of the stone implements found in New Jersey, let us now briefly refer to the historical evidence bearing upon this question. Have we any references to Esquimaux dwelling in regions significantly south of their present habitat? If there are such, then it is at once evident that the weapons and domestic implements of such people must now be buried in the dust of their ancient southern dwelling-places, and, these same spots being subsequently tenanted by the Indian, his handiwork must also be mingled with that of his predecessors.

The literature of this subject can be sufficiently outlined by reference to two authors. Major W. H. Dall, in "Tribes of the Extreme Northwest," ‡ remarks: "There are many facts in American ethnology which tend to show that originally the Innuit of the east coast had much the same distribution as the walrus, namely, as far south as New Jersey." I submit the rude argillite arrow-heads found in certain localities in such abundance, and at a significant depth, as an additional fact, tending in the same direction.

In Rev. B. F. De Costa's admirable *résumé* of Icelandic literature # there is given abundant evidence—ay, proof—that the people dwelling along the coast of Massachusetts, 900 to 1000 A. D., were not the same race that resisted the English on the same coast six centuries later. The descriptions of the people seen by the Northmen show that, of whatever race, they were well advanced in the art of war, and used not only the bow, but hatchets and the sling. They were "men of short stature, bushy hair, rude, fierce, and devoid of every grace." ‖

It need, therefore, only be remembered that the relationship between the true palæolithic implements and those of more advanced finish and design is evident to every one who carefully examines a complete series. At the same time, the student is confronted with reliable historical evidence of the occupancy of the Atlantic sea-board by the Esquimaux as far south as New Jersey.

Does not the impression derived from strictly archæological

* "Popular Science Monthly," vol. xviii, No. 1, p. 38, November, 1880, New York.

† "Peabody Museum Report," vol. ii, p. 252, Cambridge, Massachusetts.

‡ "Contributions to North American Ethnology," vol. i, p. 98, Washington, 1877.

"Pre-Columbian Discovery of America," Albany, 1868.

‖ "Popular Science Monthly," November, 1880, p. 38, New York.

studies, that all the stone implements of our Eastern sea-board are not of one origin, go far to confirm the position of the historical student that an earlier race than the Indian once resided here?

De Costa remarks: "During the eleventh century the red-man lived upon the North American Continent, while the eastern border of his territory could not have been situated far away from the Atlantic coast. In New England he must have succeeded the people known as Skrællings. Prior to that time, his hunting-grounds lay toward the interior of the continent. In course of time, however, he came into collision with the ruder people on the Atlantic coast, *the descendants of an almost amphibious glacial man*."

This "amphibious glacial man," I submit, is he who fashioned the rude palæolithic implements, that, with bones of extinct and Arctic mammalia, are now found in the glacial drift of our river-valleys; and his "descendants," a rude people, with whom the Indian finally came in contact, were those who fashioned the plainly finished argillite arrow-heads and spears that are now, in part, commingled with the elaborate workmanship of the latest race, save one, that has peopled this continent.

BODILY DEFORMITIES IN GIRLHOOD.

By CHARLES ROBERTS, F. R. C. S.*

I HOPE the time is not distant when a careful study of the living model of the child and the adult, and the whole period of the development of the one into the other, will form a part of the student's ordinary course of anatomy and physiology, as such knowledge is essential to the surgeon engaged in removing and preventing deformities of the body. Orthopedic surgery as a specialty is a great evil both to the profession and the public. The specialist who concentrates all his attention on a narrow field of study and practice is tempted to exaggerate its importance, and to analyze and disintegrate his facts till he loses sight of their relation to and their dependence on each other; while, on the other hand, the general practitioner is disheartened and repelled by the apparent complication of the subject, and is induced to hand over to the specialist many cases which he is quite competent to treat, or, as is too often the case, to undervalue the importance or deny the existence of many deformities. How else can we explain the difference in practice between the fussy mechanical ingenuity with which many professed orthopedists treat the slightest deformities of children—which, by the way, they often tell us are only visible to their specially trained eye, and are hidden from that of the

* Late Assistant-Surgeon to the Victoria Hospital for Sick Children, etc.

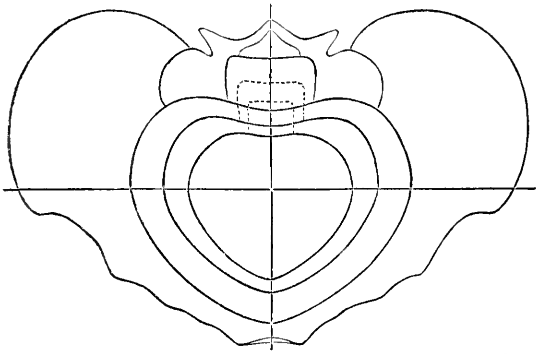
family doctor—and the *sang-froid* of the general practitioner who meets the difficulties by the administration of a few doses of steel and quinine and rest in the recumbent position?

No deformity of a child's body gives rise to so much alarm to parents, or is the subject of greater diversity of treatment among medical men, as lateral curvature of the spine, and this is due, I believe, to an imperfect acquaintance with its origin. Specialists are accustomed to treat lateral curvature, knock-knee, and flat-foot as distinct deformities, while in truth they are all links in the chain of one deformity. Lateral curvature may arise in different ways, but in all cases it is due to the loss of the lateral balance of the body in the upright position, and is the result of an effort of nature to maintain the center of gravity of the body and support the head and shoulders in the position which requires the least expenditure of muscular effort. The paralysis, wasting or loss of a limb, or the shortening of one of the legs by disease of joint, rickets, knock-knee, or flat-foot in growing children, will produce lateral curvature, and these are its chief if not its only causes. It is not a deformity arising from general debility, and I do not think it can be produced, as is often asserted, by an awkward sitting position, as in writing and other school occupations. The curvature of the spine which results from these causes is antero-posterior, or what is commonly called round-shoulder (non-carious). The tendency of debility, whether local or general, is to bring the body into the prone or recumbent position, and not to tilt it on one side.

Setting aside the cases of lateral curvature in children who have been affected with rickets, disease of joints, paralysis or loss of a limb in early life, and which affect both sexes and all ages equally, what may be called the idiopathic or acquired deformity is rarely found in children of either sex under the age of nine or ten years, and very rarely in boys above that age. It is, indeed, almost peculiar to girls verging on puberty, and is as often found in strong and healthy as in weak and delicately built girls, and most commonly in those who are too fat and heavy for their stature and age. It is a deformity which is less common among the laboring classes than among the rich and well-to-do, and is largely associated with a life of indolence and luxury.

A careful examination of the subject has satisfied me that this acquired lateral curvature in girls is due to the change in the position of the lower limbs, resulting from the development of the pelvis from the infantile to the female type a year or two before the accession of puberty. Any one who will examine the figures of young children below this age will find little differences between the two sexes. The legs of young girls are set on the body like those of boys, and, within the limits of their training and dress, they can run as well and as gracefully as boys; but as puberty approaches, and the pelvis alters its shape, the heads of the femora are removed farther from the center of gravity, and at the same time become rotated forward by the widening of the pelvis, and especially of the outlet of the pelvis. The effect of these changes is to bring the knees closer together, and to produce the weak-kneed condition and the awkward running gait peculiar to women. This condition of the limbs is well seen in pictures and statues of the nude figure, and it is often exaggerated by the artist or sculptor, probably to give a more distinct idea of a woman's helplessness or modesty. The knee-cap in women looks straight forward, while in men it is turned a little outward; and in women the knees touch, or even overlap each other, while in men they are quite free. In running, a woman has to move the knees round each other, and to throw the feet out in a succession of small semicircles, which accounts for the peculiarity in her gait. This gait is not found in young girls before the onset of puberty, and is useful as a diagnostic sign of pelvic evolution long before the ordinary signs appear.

Although this weak-kneed condition is quite normal, it is a fruitful source of deformity in growing girls. A little additional strain will convert it into knock-knee, and, by throwing the weight of the body on the inner ankle, it will quickly break down the arch of the foot and produce flat-foot or complete eversion of one or both feet. It is here, indeed, that nearly all the mischief lies, for according to my experience ninety per cent of the cases of lateral curvature of the spine in girls are associated with flat-foot. This deformity is exceedingly common among women, and a French *savant* recently quoted it as a proof of the physical inferiority of woman to man. To a slight extent flat-foot may exist in all women, as the position of the lower limbs after puberty would seem to produce it, and it may be Nature's plan to promote what anthropologists call marriage by capture; but to a large extent, and in its worst forms, flat-foot is the result of civilization. Indeed, both the highly arched instep and the everted foot are peculiar to civilized peoples, and are absent from the lower races, especially those who go barefoot, and both conditions owe their existence to the wasting of the muscles which flex the toes and foot by the constant use of tight-fitting shoes. In India, where the native workman makes use of his toes with almost the same facility as his fingers, the instep is obliterated by the fleshy bellies of the abductor of the great toe and the short flexor of the toes, which stretch across the arch from their attachment to the heel-bone. The wasting of these muscles is of little importance to us who have no need to use our toes in detail; but it is far otherwise with the deep flexors of the foot and toes which are attached to the leg-bones, and whose tendons pass under the ankle-joint and arch of the foot and form their chief support. It is, indeed, from the wasting or inaction of the deep flexor muscles, coupled with the turning out of the toes which fashion has imposed upon us, that the ankle and arch of the foot give way under the changed position of the limbs in girls at puberty, which I have described; and what is remarkable, and not easily explained, the deformity generally occurs only in one foot, or is greater in one than in the other. In this way, however, the legs become of unequal length, and we have obliquity of



The diagram shows the relation of the brim of the pelvis in the child, at puberty, and in the adult female, from measurements of pelves in the museum of the Royal College of Surgeons. The want of parallelism of the two inner pelvic curves shows that in the change from the infantile to the female type evolution takes place chiefly behind, and that the legs must be rotated forward and inward. The dimensions are—Child: breadth, 83 mm.; length, 73; index, 114. Young female: breadth, 112 mm.; length, 85; index, 132. Adult female: breadth, 143 mm.; length, 108; index, 132. The indices of the young female and the adult are the same, but the bones of the former are not united together.

the pelvis, and consequently lateral curvature of the spine to correct the balance of the body, and bring the head and shoulders into the line of the center of gravity. Flat-foot also produces, or exaggerates, the natural disposition to knock-knee in girls, which, in its turn, adds to the inequality in the length of the two legs. Some observations recently made in America show that even in adults of both sexes the two legs are rarely of equal length, and there must be, therefore, slight lateral curvature in all persons, and it is probable that these natural curves become exaggerated, as in the development of round shoulder the large antero-posterior curves of the spine are exaggerated. It is to the wasting or non-development of the fleshy parts of the deep flexors of the toes or foot that Europeans owe the small ankle and the comparatively large calf of which they are so proud as distinguishing them from the lower races. It is a distinction, however, which is more than counterbalanced by the ugliness and inconvenience of flat-foot, to which it frequently gives rise. The ingenuity of an Edison could not devise a machine so favorable to the production of flat-foot as the tight-fitting, high-heeled, long-topped boot at present worn by girls. Not only does the rigidity of the front part cramp the action of the muscles, but the high heels place the foot at such an angle with the leg that the tendons are of least use in supporting the ankle-joint, and the long tops hamper the development of the muscles in the remainder of their course. The high heels, moreover, push the center of gravity forward on the arch of the foot, and by propping up the heel gives greater leverage, and a greater space for the arch to fall when once it gives way. In the majority of cases the mischief would stop when the arch reached the level of the natural heel, but the heels of boots favor a still greater fall, which ends in eversion of the foot. It is difficult to understand how women submit to the discomfort of wearing high-heeled boots, or can be so cruel as to let their daughters wear them. It is true they give a fictitious height to the body, and disguise the slighter forms of flat-foot, but on the other hand they exaggerate the severer forms, and the boots are entirely wanting in proportion. Zeising's law of proportion requires that the sole and the heel should have the relative length of three to two, like that of the normal foot.

In treating the deformities of the spine and legs incident to healthy girls, it is obvious that attention must be directed, in the first instance, to correcting the deformed knees and feet. The very first signs of the giving way of the arch of the foot, which is easily detected by examination, by growing pains, and especially a change of gait, should be met by the wearing of flat-soled, well-fitting boots, with India-rubber or felt pads inside to support the arch, and special exercises favorable to the development of the deep flexor muscles. At puberty, and for two or three years before, the growth is very vigorous, and in both stature and bulk girls shoot ahead of boys of the same age, the period of rapid growth of boys coming later. From ten to fourteen years the stature of girls increases at a uniform rate of two inches per year, except at thirteen, when it is two inches and a half; but the weight increases at a much greater rate. At ten years girls add four pounds, at eleven six pounds, at twelve ten pounds, at thirteen twelve pounds, and at fourteen and fifteen eight pounds to their weight, and this sudden addition to the weight tells rapidly on ankles, feet, and knees, placed at a disadvantage by concurrent change in the position of the lower limbs by the evolution of the pelvis and the cramping of the muscles by tight boots. The arch of the foot often breaks down in the course of a few weeks, without warning or apparent cause, and in girls in perfect health, and especially those of an indolent habit. Fortunately, the remedy is as easy and complete, if applied promptly at the beginning and adhered to persistently, as it is difficult and unsatisfactory if put off till the deformity is firmly established. Support to the arch of the foot prevents the formation of knock-knee and lateral curvature of the spine. When it fails to do so, the knock-knee can be corrected by the temporary application of long splints, especially in bed at nights; but no apparatus is necessary for the curvature of the spine in its earlier stages, as it will disappear on restoring the lateral balance of the body, and all treatment will be useless until this is done. Much walking or standing should be avoided, and short but vigorous gymnastic exercises substituted, and when possible the recumbent position assumed. Sitting on the ground or on a sofa, in the cross-legged, Oriental position, serves to expand the pelvis, evert the knees and invert the ankles, and counteract all the deformities; while sitting on chairs with the legs crossed one over the other directly favors them. It is probable that most children spend too much of their time on their feet, and that their power of walking is very much overrated. Running is the natural gait of all young animals, and children always run if left to play by themselves. The dire effect of standing and walking in producing flat-foot in children is shown by the following statistics, taken from my paper on "Flat-foot," in the St. George's Hospital Reports (1872–'74): Of 10,000 children, between the ages of eight and thirteen years, which were examined, about one third were school-children living in country towns and agricultural districts, another third were school-children living in manufacturing towns, and the remainder were factory-children. Among the first, 17·1 cases per 1,000 of flat-foot occurred; among the second, 30·7 cases per 1,000; and among the third—i. e., the factory children, who were employed five hours daily standing, walking, and carrying weights—79 cases per 1,000 of flat-feet were found. Among the latter the deformity was found to increase rapidly with age—i. e., with the longer period of employment in factories. Thus:

Of the age of	8 years,	15·1	per 1,000	had flat-foot.
"	9	"	45·6	"	"
"	10	"	51·2	"	"
"	11	"	104·2	"	"
"	12	"	132·4	"	"

At the period when these observations were made (1873) children were allowed to commence work in factories at the age of eight years, instead of ten as now, and the low rate of 15·1 per 1,000 represents the normal rate before the strain of labor has begun to tell on the children's feet.

There can be little doubt that children are made to stand and walk far too much both at home and at school. Standing at lessons, parade-exercise, and much of the military drill in schools are injurious to both boys and girls, and especially to the latter. Instead of listless standing about, or taking long walks with adults, children should be permitted and encouraged to play lively games, which they will generally do even if left to themselves, to dance, and to perform short but spirited gymnastic exercises with apparatus. Exercises which develop the muscles of the feet and ankles, such as hopping and skipping, are especially necessary for girls; and still better than these are the admirable exercises preparatory to stage-dancing taught at the National Training-School for Dancing.* These exercises are directed to the development of the muscles and the free action of the joints of the lower limbs, and are far preferable to the languid movements of ordinary dancing. For the development of the muscles of the trunk and

* Under the direction of Madame Katti Lanner.

arms the excellent system of gymnastics for girls recently established by a lady * in various parts of London, with the approval, after careful and repeated inspection by myself, of Dr. Richardson, Mrs. Garrett Anderson, and others, is all that can be desired. The Swedish and other exercises effected without apparatus are of little use, as idle and indolent girls who stand most in need of physical training easily comply with the form, but evade the spirit and hearty compliance which such systems demand. These systems lack motive to complete an exercise, while simple apparatus, such as balls, dumb-bells, and bars, compel it by keeping the end in view, and giving an impetus to its performance. With half the care which mothers spend on dressing and decking-out their children, often in unsuitable clothing, they might, with a little help from their medical advisers, prevent most of the deformities which mar the physical beauty, comfort, and health of their offspring; and no time seems more appropriate than the present for directing the attention of medical practitioners, and through them of parents, to the means of attaining these objects, as the short walking-dresses worn by women and girls at the present time reveal to all of us to what a great, indeed unexpected, extent the ugly deformities of the feet and ankles to which I have referred exist, especially among the well-to-do and higher classes.—*Lancet.*

TIME-KEEPING IN LONDON.

By EDMUND A. ENGLER,
WASHINGTON UNIVERSITY, ST. LOUIS, MISSOURI.

II.

THE distribution of the Greenwich signals from the General Post-Office in London is effected by means of the Chronopher or Time-carrier,† shown in perspective in Fig. 6, and in front elevation in Fig. 7.‡ To this instrument the hourly signal from the observatory is sent by means of a special under-ground wire. Branching out from it are four groups of wires: 1. *Metropolitan*, running to points in London only. 2. *Provincial Short*, to points not more than fifty miles from London, as Brighton, etc. 3. *Provincial Medium*, to points farther away, as Hull, etc. 4. *Provincial Long*, to extreme points, as Edinburgh, Belfast, etc. # The ends of each of the four groups are brought

* Miss M. A. Chreiman, 69 Petherton Road, N.

† There are actually two of these; the one shown in the figure is the new and larger one.

‡ For a description of the chronopher, from which the above is condensed, and for drawings from which Figs. 7, 8, and 9 have been made, the writer is indebted to William H. Preece, Esq., Superintendent of Telegraphs, London.

The Greenwich signals are sent into Ireland only for purposes of comparison; Dublin time is used throughout the island.

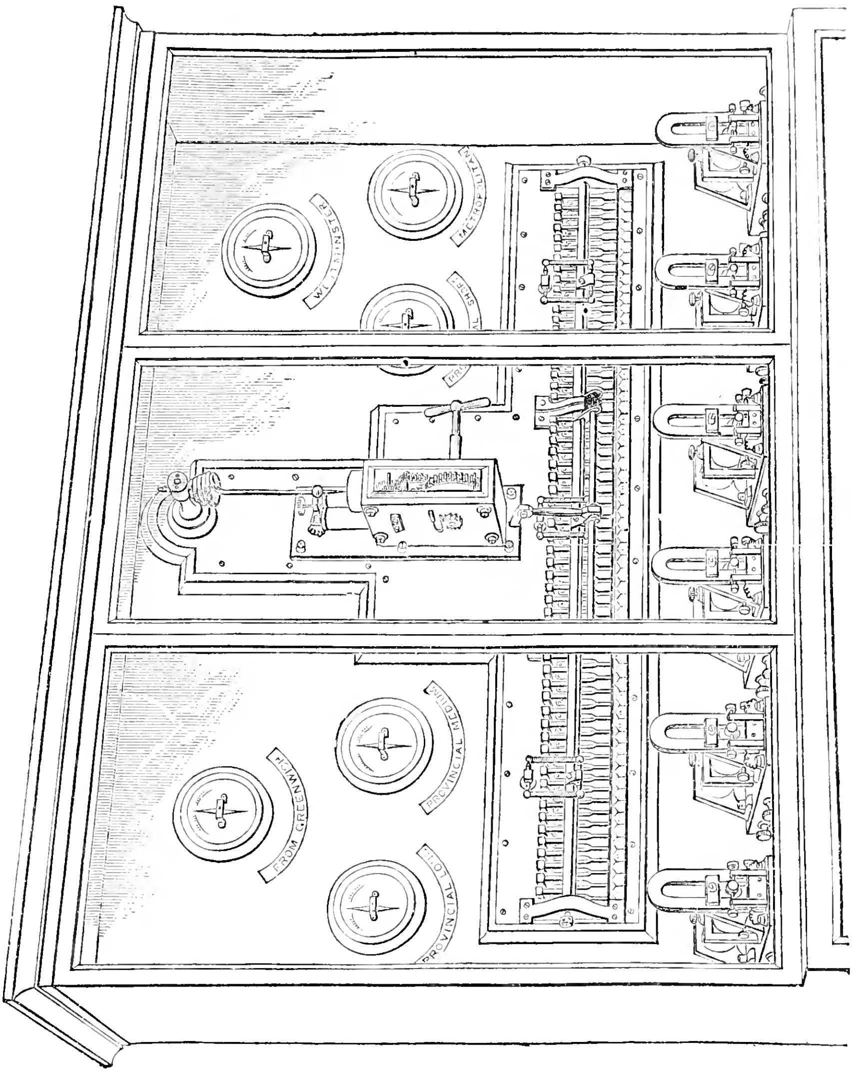


FIG. 6.—THE CHRONOPHER.—PERSPECTIVE.

together, and each group has a separate relay, in order that the shorter may not unduly deprive the longer lines of their share of the current. The four relays are all worked by the hourly signal from Greenwich, and therefore act simultaneously. The lines of the *Metropolitan group* are used only for time purposes, and are therefore always connected with their relay, and distribute the signals hourly. But the lines of the other groups are in use generally for ordinary telegraphic purposes, and distribute time-signals only at ten and one o'clock. At these hours, therefore, the wires must be switched off from their ordinary duty, and placed in communication with their respective relays to be ready to receive the time-signals. The electrical working of the apparatus which accomplishes this will be understood by reference to Fig. 8.* Under normal conditions, the current from the observatory passes

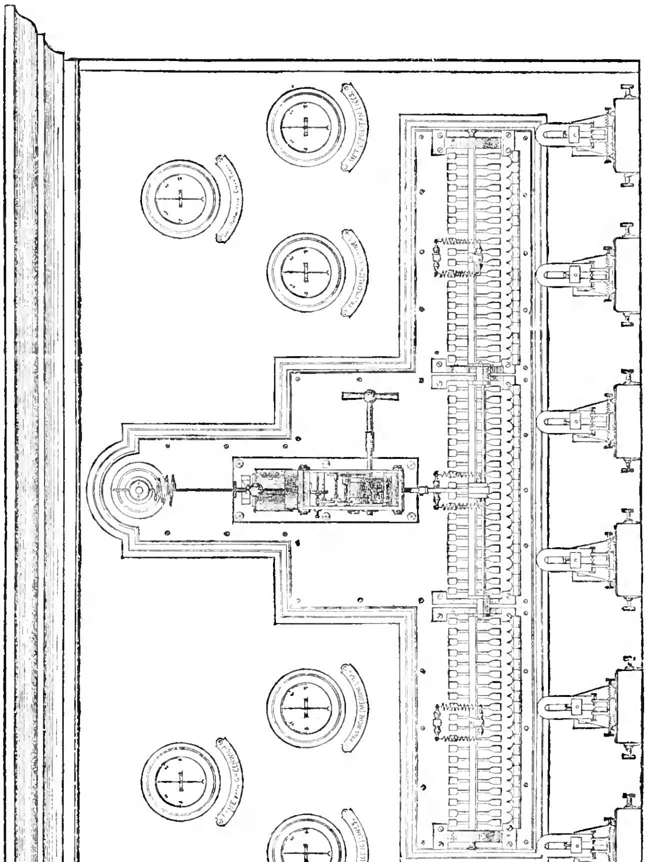


Fig. 7.—The Chronopher.—Elevation.

directly through the chronopher, and out at the galvanometer G′, to the tower-clock at the Houses of Parliament, Westminster. This clock has a gravity escapement, and a metallic compensating pendulum, very similar to the pendulum of the Sidereal Standard, already described, and runs with a rate of less than one second per week. The

* The small figures 1, 2, 3, 4, to the right of Fig. 8 and to the left of Fig. 9, show the connection between the wires.

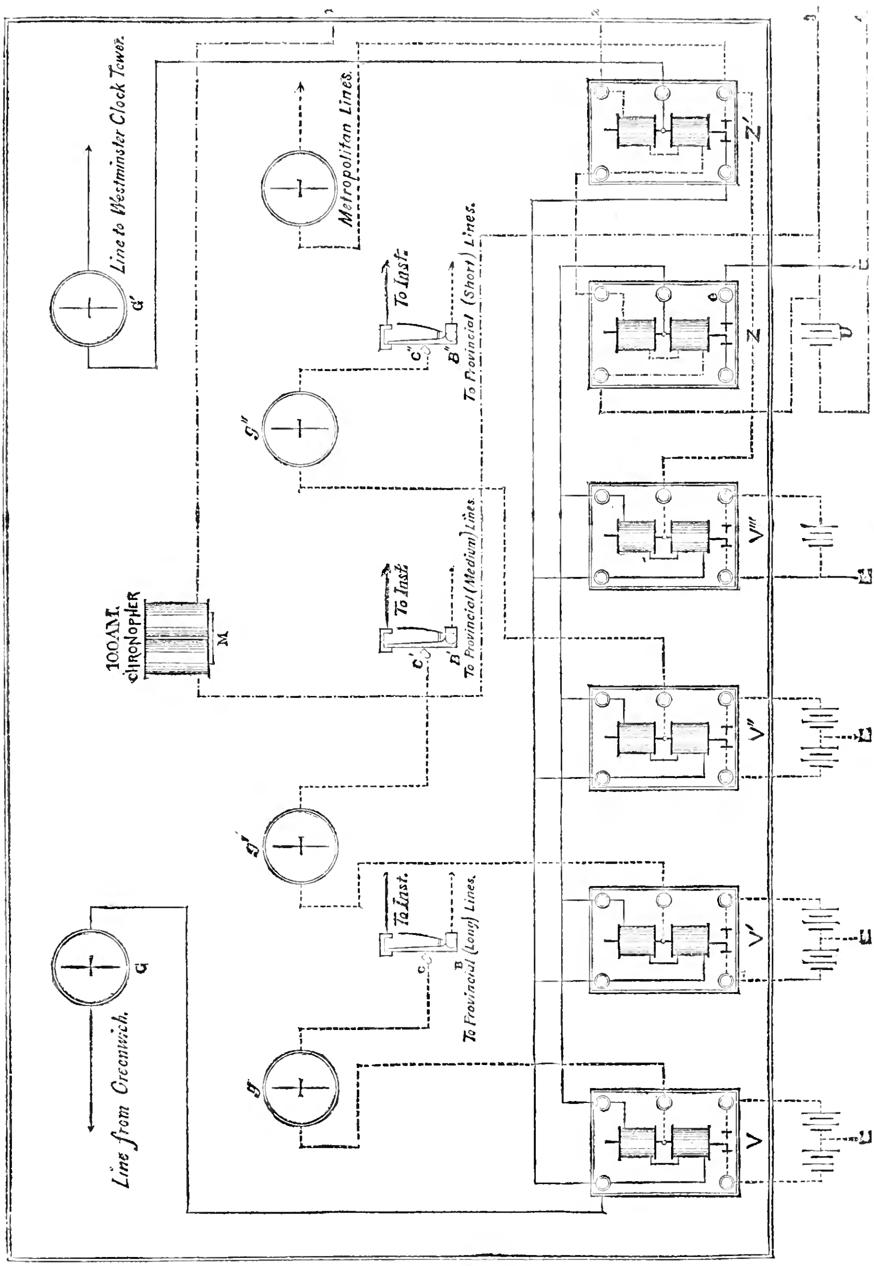


Fig. 8.—Diagram showing Electric Connections of the Chronopher.

current from Greenwich in no way controls the Westminster clock, but is simply used for rating the clock by comparison; when change of rate is necessary, weights are added or removed at the pendulum.

Each of the line wires is in permanent connection with one of a set of jointed vertical bars (B, B′, B″), which, except at the times for the signal, are kept in contact by springs with cocks in the circuit of the wire; but at the times for the signal a long metallic bar (C) acting as a cam (better shown in Fig. 7, in front of the vertical bars), is made by clock-work to disconnect all these bars from their instruments. The bar (C) is divided into three parts, corresponding to the long, medium, and short provincial lines, insulated from each other, and connected respectively with the bars of the relays (V, V′, V″) through the galvanometers (*g*, *g*′, *g*″, Fig. 8). The left or rest contacts of these relays are in connection with the zinc poles of separate batteries, whose copper poles are grounded, so that, when the bars of these relays are put in connection with the line wires, a zinc or "preliminary" current is ready to be sent out; this current prevents the distant relays from being actuated by contacts or accidental currents, and serves as a warning signal. The right-hand contacts of the relays are connected respectively with the copper poles of separate batteries whose zinc poles are grounded, so that, when the bars are moved over to the right (which is done by the incoming Greenwich current), the outgoing current is reversed, and this constitutes the signal. The relay V‴ is for distributing the signals only to points in the metropolis, and, as the wires on these lines are under ground, no "preliminary" current is necessary.

The mechanical operation of the apparatus is as follows: On the clock (R, Fig. 9) there is an ebonite wheel (W) in which are two notches (N, N′) corresponding to 10 A. M. and 1 P. M. Shortly before 10 A. M. the pin (P) on one arm of the forked lever (L) falls into the notch (N), allowing the end (Q) of the other arm to rest on the ebonite hour-wheel (T). About two minutes before the hour, the end (Q) comes against the contact (S), and completes the circuit of the local battery (U, Fig. 8) through the starting magnet (M, Fig. 9) and sets the clock-train (shown in Fig. 7) in motion, pressing the cam (C) against the vertical bars, disconnecting them from their instruments, and connecting them respectively, in groups as already shown, with the relays (V, V′, V″), in readiness to send a "preliminary" current to the line wires. At ten seconds to the hour an insulated pin (*i*, Fig. 9) on the wheel (T) lifts the lower arm of the forked lever (F), so that its upper arm comes in contact with a small cam on the arbor of the escape-wheel (K). This contact closes the circuit of the battery (U) through the coils of the two relays (Z, Z′). The relay (Z) puts on the earth connection at (E), for the four relays (V, V,′ V″, V‴), so that the current from Greenwich may be received and divided between them, while the relay (Z′) disconnects the Westminster clock-wire and connects it with the metropolitan lines to receive the signal from the relay (V‴). The relays (V, V′, V″, V‴) have a resistance of 5,000 ohms to allow of the splitting of the current. At precisely ten o'clock the Greenwich signal reverses the current on the lines, and thus gives the exact time. At ten seconds past the hour the contact between H and K is broken, the relay-bars go back to their normal position, the train-work moves away the cam (C), and restores the vertical bars to connection with their instruments.

The apparatus which effects the shunting at one o'clock is somewhat different in construction. The pin (P, Fig. 9) falls into the notch (N′),

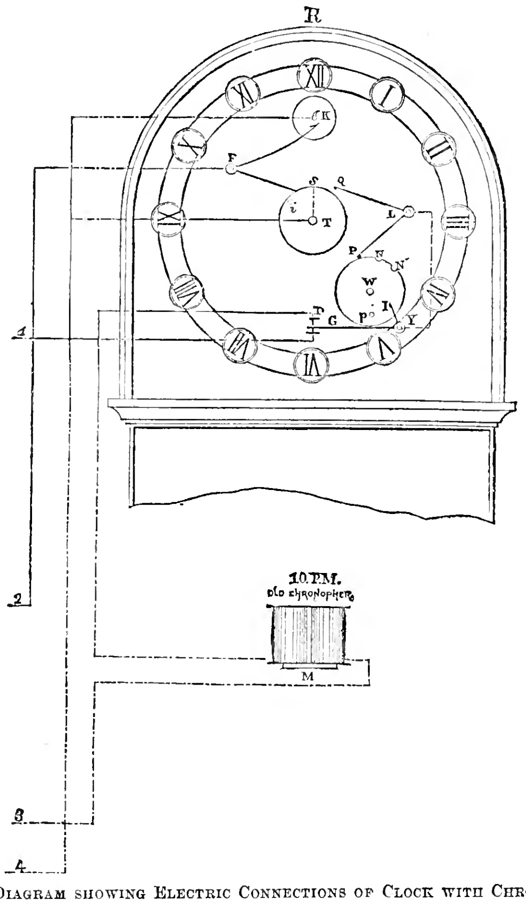


FIG. 9.—DIAGRAM SHOWING ELECTRIC CONNECTIONS OF CLOCK WITH CHRONOPHER.

a pin (p) on the wheel (W) coming against the arm (I) of the forked lever (Y) raises the flexible arm (G) against the upper contact (D), so that the circuit of the local battery (U) is closed through the starting magnet (M), which operates the one o'clock train-work.

Wires which receive both the ten and one o'clock signals pass through both switching arrangements.

For the hourly currents on metropolitan lines the relay (V‴) serves, by closing the circuit of the battery (U) at the contact (K), the rest of the apparatus remaining inoperative.

The actual interval during which the Greenwich as well as the provincial wires on which the time-signal is distributed are kept in circuit being only twenty seconds, the chance of interruption from contact currents is reduced to a minimum.

The batteries in use are large Leclanché cells, and the power is distributed as follows:

	Copper or "time" battery.	Zinc or "preliminary" battery.
Long lines	80 cells.	60 cells.
Medium lines	60 "	45 "
Short lines	40 "	30 "
Metropolitan lines	40 "	.. "

The Greenwich signal, thus distributed by the chronopher, goes to all parts of the kingdom, and affects receiving instruments provided for the purpose. These are of various kinds; ordinary telegraphic sounders, electric bells, and galvanometers have been used with success to note the arrival of the signal. The current has also been made to drop time-balls on the tops of buildings, to expose a model time-ball to view, and to fire guns.

To test the accuracy of the signals, experiment has been made by returning a wire to Greenwich from the chronopher, and comparing the signal received on this wire with the signal sent from the observatory; no difference could be perceived between the indications of two galvanometers placed side by side showing the passage of both currents. The signals were thus shown to be entirely reliable. But it does not seem likely that the chronopher will be introduced elsewhere, because simpler means have been devised for splitting up the current and distributing the signals.

The whole system is under the control of the Post-Office Department. They own the wires—which, except in London, are the ordinary telegraph-wires—and therefore contract to keep them in order, to clear them each day at the signal-times, and to deliver at these times the Greenwich signal. Maintenance of lines and apparatus not the property of the department is undertaken by the department for any period not less than one year at specified rates. A simple form of agreement has been prepared, which every renter is required to sign. This agreement, as a rule, is for not less than three years, and is terminable at three months' notice given previous to the end of the fixed term, or, failing such notice, on payment of such sum as the department may accept instead. But where the expense of construction is considerable, the term must not be less than from five to seven years, the latter period being stipulated when the proposed line is in an outlying district and would be specially provided for a single renter, and when it is not probable that there would be other renters.

The annual charges for the use of wires and apparatus are as follows:

From London to the country:* For the 10 A. M. signal, £12 to £17 = $60 to $85. For the 1 P. M. signal, £27 to £32 = $135 to $160. In London: For the hourly signal within a radius of two miles from the General Post-Office, £15 = $75. But if the person desiring the signal is off the line of the telegraph, he must pay, besides a stipulated rental, an additional sum for the use of the wire which the department is compelled to put up specially for him. The rental is in all cases payable yearly in advance.

In 1880 there were one hundred subscribers to the system, of whom nineteen were in London, and eighty-one scattered through England, with a few in Scotland and Ireland.

Besides this general automatic distribution of the time-signals, a considerable distribution of the 10 A. M. signal goes on by hand. At that instant the chronopher makes a sound which an operator sits ready to catch by ear. Upon hearing it he immediately dispatches a signal by the ordinary telegraphic instrument, and this signal is received at six hundred or more places, which again serve as distributing points for more distant places. These are usually railway or post offices in towns not supplied by the chronopher, which by virtue of authority become the regulators of the clocks of the surrounding district.

The wire from the observatory to London Bridge carries signals hourly from the mean solar standard to a clock at the station of the Southeastern Railway, which by changing connections sends Greenwich time to different stations along the line as may be required. For this service the Southeastern Railway gives the observatory the use of its wire daily, for a few minutes, at 1 P. M. At this time the current from the observatory drops the time-ball at Deal, which was erected in 1855, to give time to the shipping in the Downs, and is the only official coast time-signal. The ball in falling sends a "return" signal to the observatory. The record shows that about once in two months high wind prevents the raising of the ball, about once in six weeks it fails to fall on account of some fault in the electric connections, and about once a year it drops out of time. Under such circumstances it is dropped correctly at 2 P. M.

By special arrangement with the observatory a few London jewelers receive the hourly Greenwich current on private wires. This they use for the correction of their own time-keepers and in some cases for distribution. Prominent among these are the Messrs. Barraud & Lund, of Cornhill, who have patented a method for the synchronization of clocks. Their plan is put forward as a simple and effectual means of setting any number of ordinary clocks to the same standard time. All attempts to control clocks have been set aside as impracti-

* Difference in charge for the same signal depends on the length of wire which the department is compelled to put up specially for the subscriber. The one o'clock signal is more expensive, because the wires are busier with telegraph duties at that hour than at 10 A. M.

cable, and a system adopted whereby the clock is automatically "set to time" every hour, or at such intervals as may be arranged. The apparatus can here be described only in brief. There are three essential parts, the *standard clock*, the *distributor*, and the *synchronizer*.

The standard clock is an astronomical regulator with mercurial pendulum and dead-beat escapement, and closes an electric circuit at the sixtieth second of each hour. Another regulator, technically called "Lobby," is for use in case of accident to "Standard." They are so connected that a single failure of "Standard" to send out a signal at the proper time brings "Lobby" into action for the next signal, and, in order that "Lobby" may always be ready for service, an intentional breakdown of "Standard" occurs automatically at eight each morning, and the nine o'clock signal is sent out by "Lobby"; which of the two is in operation is shown by indicators connected with the clocks (Fig. 10).* Should a breakdown occur, the indicator of "Standard" would show *missed*, and that of "Lobby" *at work*.

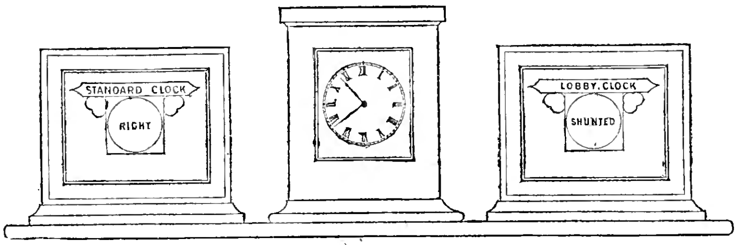


Fig. 10.—Barraud and Lund's Indicators.

The error of the standard clock is determined daily by comparison with the Greenwich signal. An ordinary dotting chronograph is set to the standard clock, and the Greenwich signal makes a dot on the chronograph-dial which gives at once the error of the standard and can be read off at leisure. It is corrected by electric means. The pendulum carries a small permanent magnet which swings over a resistance-coil about $\frac{1}{16}$ inch distant. The coil is connected with the commutator in the test-box (Fig. 11), consisting of a clock commutator with plugs for "Standard" and "Lobby," a current commutator with plugs for "Fast" and "Slow," and a small time-piece, shown at the top. The time-piece has only a minute-hand, and is made so as to stop itself and break circuit at XII, but closes circuit when running. The working is thus: Suppose "Standard" is found to be slow. Plugs are inserted for "Standard" and "Slow," and the hand of the time-piece is set back a required number of minutes. It then runs to XII and stops. In this interval the action between the magnet and the coil has exactly corrected the standard clock. For every $\frac{1}{10}$ second of

* Figs. 10, 11, 12, and 13, have been reduced from drawings in "The Railway Engineer," London, by permission of Messrs. Barraud & Lund.

error the hand of the time-piece must be set back five minutes. When the setting is done, no further attention is required, all else being automatic.

The distributor (shown in Fig. 11) consists of twelve contact-springs, each connected with a line of wire running through a district of London, and twelve contact-screws, each connected with a battery.

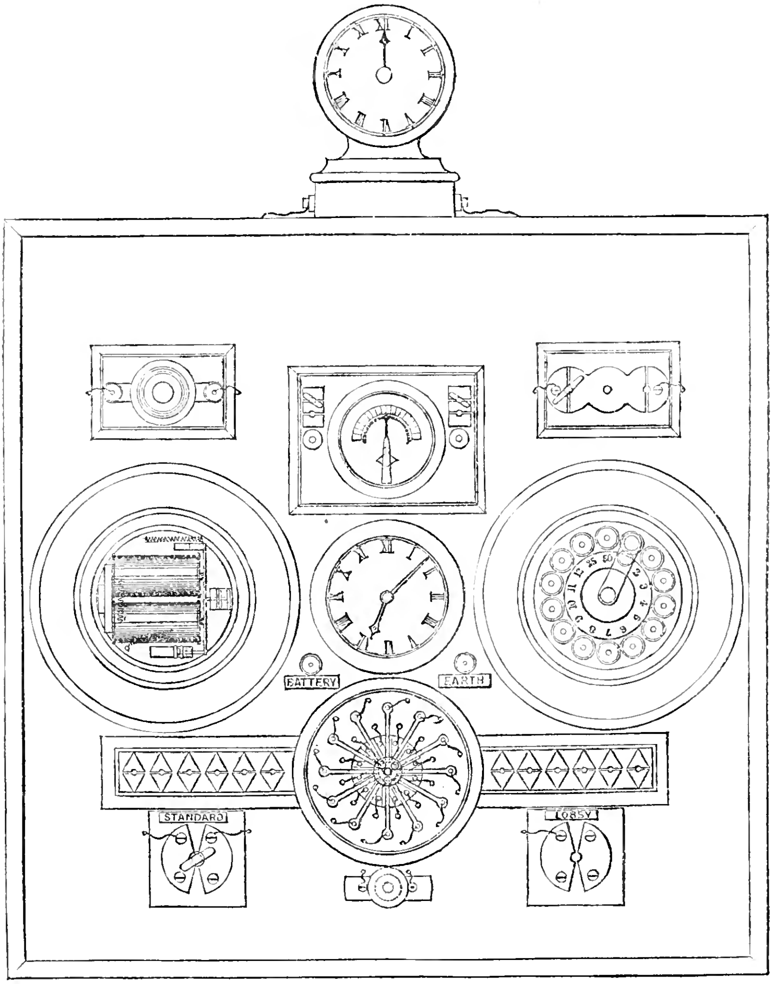


FIG. 11.—TEST-BOX.

The springs converging to the center press up against a small plate, one inch in diameter, which is controlled by an electro-magnet in the circuit of the current which the standard clock sends out hourly. When the signal comes, the plate is pulled down and presses every spring against its contact-screw, and the signal goes out over each of the lines.

The synchronizer is the receiver of the signal, and consists essentially of an electro-magnet, in the circuit of one or other of the lines from the distributor, with armature carrying two counterpoised levers

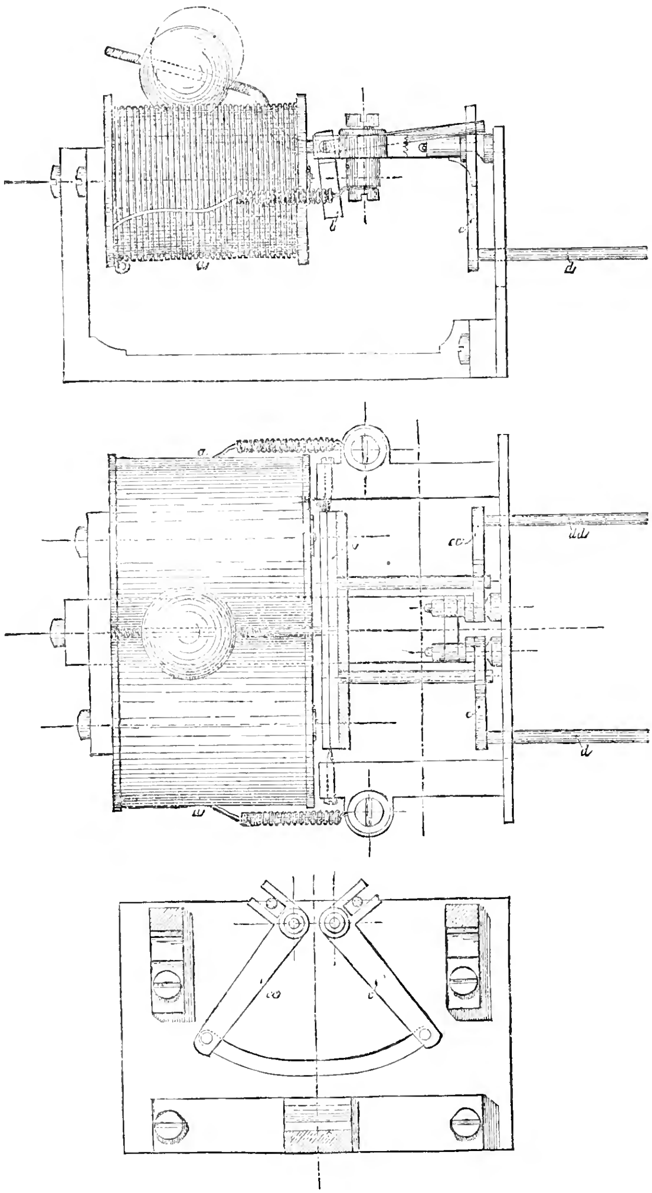


Fig. 12.—The Synchronizer.

each provided with a projecting pin. When the signal arrives, the electro-magnet attracts its armature, and the two pins are brought close together. The mechanical operation will be understood by reference to Fig. 12, where a side elevation, a plan, and a front elevation are shown. This apparatus is fastened to ordinary clocks just back of the dial-plate (Fig. 13). A curved slot is cut through the dial for a short space on each side of XII, and through this the pins project. When, at the end of the hour, the signal arrives, the two pins are pushed together and bring the minute-hand exactly to XII. The position of the pins before and just after the operation is shown in Fig. 14. Evidently the clock must not be in error more than two minutes or so; but, as the hand is set every hour, any ordinary clock can be kept right by this device.

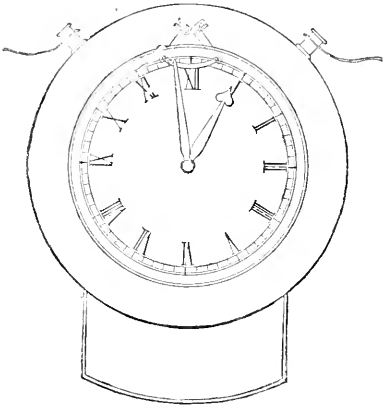


Fig. 13.—Face of Clock with Synchronizer attached.

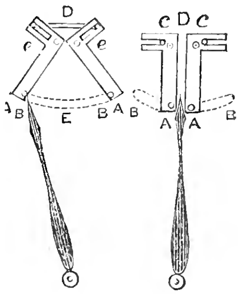


Fig. 14.

Other ingenious arrangements have been added to guard against danger, always present to long lines of wire, and for testing the condition of the lines, but a description of them can not here be given.

The advantages claimed for the system are:

1. That any number of clocks of any varying sizes can be synchronized to any agreed standard time-keeper.

2. That the mechanism is, when not in momentary use, entirely detached from the works of the clock.

3. That it can be applied to existing clocks.

4. That any failure in the transmission of the time-current leaves the clock going in the ordinary way, to be "set to time" by the next completed current.

5. That the clocks are kept to time whether having otherwise either a gaining or losing rate, even if such rate amounts to many minutes a day.

In London the system has been in successful operation for about five years, and has been used over a wire four hundred miles long. The subscribers number about five hundred, among them many railroads and public institutions.

In connection with the synchronized clocks, Messrs. Barraud and Lund have also established time-bells and flashing-signals, which afford

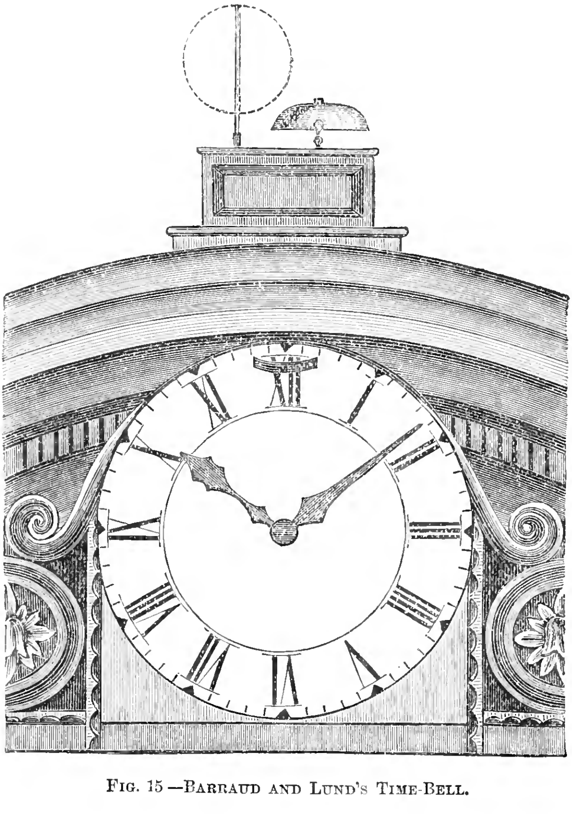


Fig. 15.—Barraud and Lund's Time-Bell.

time-signals both to the ear and eye. These are shown in Figs. 15 and 16. The bell is an ordinary electric bell, and is rung by the regulating clock, which closes the circuit at the instant the signal is desired. The flashing-signal consists of a red vertical disk on a vertical axis, which normally shows only its edge, but is made to revolve once on its axis in four sudden jumps, by simple mechanism in connection with electro-magnets, when the regulator, by closing the circuit, sends the current. The appearance is that of two flashes of red as the disk revolves.

In many places where noise prevents hearing a bell, the flashing-signal becomes a necessity. It is in use at the London Stock Exchange, and serves to indicate the exact instant of noon.

The method of synchronizing clocks is becoming rapidly popular throughout the world, and has been patented in most civilized countries. It is already in use in Australia and South America, and in some of the countries on the Continent of Europe. In this country, at New Haven, Connecticut, a "Standard Time Company" has been formed, who have bought the patent for the whole of the American Continent, and are now engaged in manufacturing synchronizers. An effort will be made by them to bring about a concerted system of time-signaling throughout the country. Local affiliated companies will be formed, and there is little doubt that the great simplicity and practical success of the method, combined with its cheapness, will secure its extensive adoption in all the large cities of the country.

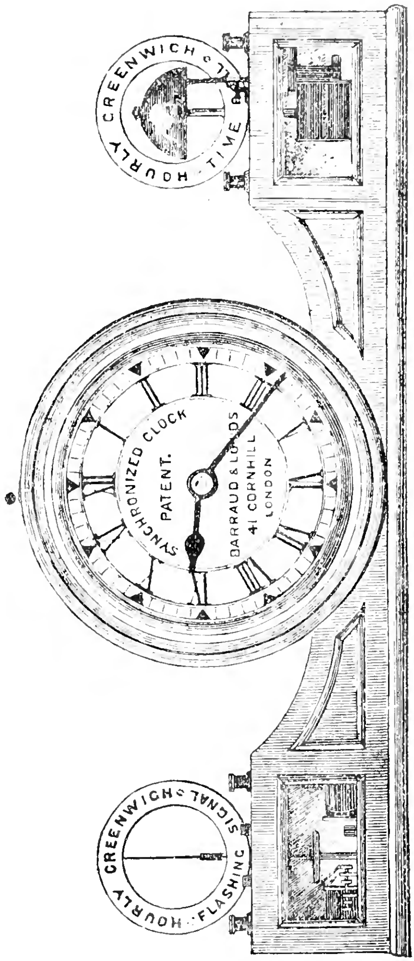


FIG. 16.—BARRAUD AND LUND'S TIME-BELL AND FLASHING-SIGNAL.

A MASTODON IN AN OLD BEAVER-MEADOW.*

BY SAMUEL LOCKWOOD, PH. D.

ON the 7th of June, 1882, a farmer, while cutting a drain through a meadow on his farm at Freehold, New Jersey, observing the appearance of bones, stopped the workmen, and sent for me to inspect the place. This I did the next morning. Approaching the spot, I

* "On a *Mastodon Americanus* (Cuvier), found in a Beaver-Meadow at Freehold, New Jersey, by Samuel Lockwood." Read at the Montreal meeting of the American Association for the Advancement of Science, August, 1882.

found it was a deep depression in the farm, and the site suggested the possibility of an ancient beaver-dam. But in that case a stream should be seen flowing through the middle. There was none there. I learned afterward that formerly there was just such a stream, but that in order to utilize the meadow it had been diverted to one side of the valley or depression, and the channel thus left had been filled up by taking from the banks or higher slopes; after this it was planted with corn. I found a drain about eighteen inches wide in progress of construction across this meadow. The ditcher had literally cut through a buried monster precisely at a point which took away a part of the bases of the tusks and some portion of the face of the animal. It was indeed a veritable mastodon. Digging under my direction was at once resumed. Both tusks were soon fully exposed, and the left one was successfully uncovered and removed to the side of the drain. Before removal I took exact measurements, and fortunate it was that I did, for in a very few minutes after being put on the dry ground it separated or unfolded, like the concentric layers of an onion, and in a few minutes more began crumbling into powder. The concentric rings thus separated were uniformly a quarter of an inch thick, so that these unfoldings gave no hint of the animal's age, for the ivory was so fine and compact that no smaller divisions were discernible. This splendid ivory was in consistency like new white cheese, and the surfaces of separation gave the precise feeling to the fingers as when they are passed over a freshly cut piece of soft cheese. The left tusk was removed almost entire; the right tusk was nearly all removed, and fragments of both were secured, though very soft and unsatisfactory, for upon drying even these selected fragments crumbled to powder.

Four molars were obtained, which were found in exact relative position to the tusks. So soft were the bones that all further digging only provoked sighs of disappointment. Of course, the position of the two tusks indicated that of the skull. We tried carefully to uncover the head so as to save it, but in vain. The spade took up a spit of dark substance which proved to be the arched forehead of the brute, which also crumbled away after a short time. But a wonderful story that short time told. This high-vaulted forehead might please some amateur phrenologist, but as a cerebral indicator of intellect it was an immense fraud. It was the genuine elephant forehead, "only more so." On cleaning it, by gently pulling out certain tufts of fine roots and vegetable fiber, this great piece of bone was literally honey-combed with air-cells, each one big enough to hold a hickory-nut. These were the extraordinarily developed frontal sinuses.

But a word about the tusks. The two were in the normal position, as of the animal lying on its right side, with the back toward the ancient stream. The ditcher had nearly destroyed one of the tusks by attempting to get it out before my arrival. The upper one, that is, the left tusk, had lost all that portion which had been cut through by the ditching. There was in the side of the ditch enough visible before the uncovering to show that the destruction had taken away much of the base, being nearly all that part of the tusk containing the pulp-cavity. The surface of the soil was carefully removed, and measurements taken. The part uncovered was four feet four inches long. Between this and the place of insertion in the skull was about eighteen inches—and for insertion two feet should be allowed—when the entire length of each tusk would be seven feet eight inches, and the weight of the ivory in each hardly less than two hundred pounds. The tusks had a slight upward curve.

The digging was continued next day, the whole area being examined. The peculiar dark stain covered a space not less than fifteen feet in length and six feet in width. It was evident that the head was inflected toward the chest. It is pretty certain, then, that a line taken from the base of the trunk to the root of the tail would not be less than seventeen feet.

The burial-place of this great beast is to me of intense interest. The body lay on its side, on a hard sand bottom, the upper parts being surrounded and but thinly covered with muck, or vegetable peat. I am satisfied that it died on the dry bank of an ancient stream. Now came a singular discovery which served as a key to the difficulty. Lying on the skeleton at different parts were the sticks or heart-remains of red cedars (*Juniperus Virginiana*, L.); they were beaver-logs. Here a singular piece of experience came to my aid. I had quite recently discovered and studied the details of two fossil beaver-dams but two miles west of this place, and the physical features of this mastodon's burying-place were in all respects indicative of a former beaver-dam. In fact, no other hypothesis could account for these sticks, with others of different woods, which have been exhumed in this meadow. It is observable that a pond made by beavers has in time its meadow as a natural consequence, and that, after the pond is deserted by these animals, the dam breaks down slowly, and, as the pond area decreases, the swamp area increases, and a growth of vegetation sets in which becomes the peat-bog, afterward the meadow. The place where the mastodon lay in course of time became covered by the waters of the pond, for beavers keep lengthening their dam to increase the area of the pond, and only stop so doing when the natural opportunities of the situation are exhausted. Of course, it was only the skeleton of the beast which was buried, and the bones might have been there long before peat-growth began over them. This explains the decomposition of the bones, for peat is antiseptic, and they should have been preserved, but it was a slow burial, and slow decay had long before set in. A curious fact seems to me to confirm the above. The huge air-cells in the bones and the great pulp-cavities of the tusks were packed solid with vegetable matter, but so unlike the imbedding peat as to be remarkable. This packing, which filled the slightest crevices and open spaces in the bones, was in every case *root*-fibers. I took out of the pulp-cavity of one tusk a compact cone of these rootlets. I have seen precisely the same thing when opening a small drain-pipe which had become choked with the roots of a tree.

Two facts have much impressed me—the great geological antiquity of the mastodons as a race, and the very recent existence of the individual we are discussing. The race began in Miocene time; this individual lived in the Quaternary age, and well up into the soil-making period. There is little if any differentiation of the molars. The cusps, or teats, on the crown are high and prominent, although I think it must have been one of the very last of its tribe. Though the race came before those great castors now extinct, this individual was contemporary with the existing beaver, and doubtless with the aboriginal man.

It is singular that in the present controversy respecting the subsidence of a part of the eastern coast-line of the United States, I have never seen the testimony of the mastodon put in evidence. As already said, this animal has run through a long stretch of geologic time. I saw a tusk taken from the Trenton gravels of New Jersey which belong to the ice age, or glacial epoch. I have part of a tusk taken from the shore in Monmouth County, New Jersey, after a storm. This storm from the sea had washed away the drift which covered an ancient swamp, in which this relic, with other bones, had been entombed. But that swamp had been far inland, sufficient for a depression to exist far enough away from the action of the sea to enable it to support a non-marine, sub-aquatic vegetation. The subsidence had allowed the sea to come up and uncover that creature's grave. Last summer, at Long Branch, I saw a fine mastodon's tooth which was taken up by fishermen out at sea. I have also some fragments of a mastodon's tooth, besides an almost entire one of remarkable size. I consider it the sixth,* or last tooth developed. It was given me as coming from Long Branch, where it was obtained so long ago that its history was forgotten. I detected upon it the microscopic skeletons of marine *Bryozoa*, the same species that I have often found on the shells of our modern oysters. This tiny animal can only attach itself to a clean anchorage in the clear sea-water. Hence this tooth was evidently got from the sea; and, more, its old grave of mud or peat was long ago invaded by the sea and churned up, so as to float it away, leaving the tooth on the clean, sandy ocean-floor.

* Not counting the tusks, the elephant has only eight teeth in his mouth at any one time—two molars on each side of each jaw. The forward tooth of each pair is pushed forward until it disappears. The back one then is pushed forward, and replaces the one lost. This goes on until six molars have appeared on each side of each jaw, so that the full-aged animal has in its life-time twenty-four molars. The tusks are monstrously developed incisors. While the true elephant has normally but two tusks, the male mastodon has four, two small ones in the lower jaw, which, however, are shed before adult age.

So it is plain that the mastodon came into what is now New Jersey ere the ice-sheet began. It receded south before it. It followed the thawing northward, and so again possessed the land. It occupied this part of the country when its shore-line was miles farther out to sea than it is to-day. Here it was confronted by the human savage, in whom it found more than its match; for, before this autochthonic Nimrod, Behemoth melted away.

CURIOSITIES OF SUPERSTITION.

By FELIX L. OSWALD, M. D.

SOME of the higher animals have a peculiar faculty for accustoming themselves to various kinds of poison; and man, especially, often owes his ruin to that unfortunate talent, for the instinct of taste can be so perverted that the vilest and originally most repulsive substances become the most seductive.

There is a curious analogy between this corruptible sense and the intellectual (rather than moral) constitution of the human mind. It may be doubted if any man ever loved injustice for its own sake, or voluntarily connived at its habitual exercise. History proves that successful tyrants could maintain themselves only by favoring a strong party at the expense of the weak. Pisistratus, Hiero, the elder Dionysius, Vespasian, Mohammed Baber, and Haroun, miscalled Al-Raschid, were the idols of the army and of the poor. Even Mehemet Ali had his redeeming qualities. Men can stand only a limited amount of iniquity. But their intellectual tolerance has no such limits. Persistent misrulers come to an evil end, but the founder of a sect, a school, or a new creed, may

"... reign without dispute
In all the realms of nonsense, absolute"—

and it even seems as if in the struggle for supremacy the most insane dogmas had the advantage over moderately absurd ones, just as opium is apt to supersede brandy and tobacco. In China, where the neutrality of the government gave all creeds a fair chance, the fate-worship of Confucius was eclipsed by the Buddhistic worship of sorrow. In Greece, the orthodox polytheists held their own against all heresies. The pure theism of Abd-el-Wahab was throttled by the champions of the Sunnitic traditions. In Rome, where the struggle for existence was fought out by fourteen or fifteen different creeds, theists, pantheists, Nature-worshipers, agnostics, and all kinds of speculative philosophers had to yield to the Asiatic miracle-mongers with their Nature-hating fanaticism and Buddhistic crotchets; and Buddha himself was baffled by that *ne plus ultra* of systematic insanity, the creed of the orthodox Brahmans. Buddhism, the worship of death and sorrow, has, indeed, almost vanished from the land of its birth. Its infatuations prevailed against the primitive religions of the Mongols, Siamese, Cingalese, Tartars, and Thibetans, but in Hindostan the cow and monkey worshipers carried the day; the champions of Sakya-Muni had found their match, and, after an hierarchical rough-and-tumble fight of fourteen hundred years, their doom was sealed by a crushing defeat. In vain the Dalai Lamas convoked council after council; in vain the bonzes howled on the highways and prayed day and night on the public streets—the monkey Hanuman triumphed, and at this moment a hundred and twenty million Hindoos are ready to risk their lives in defense of a creed which, in the words of Baron Orlich, "combines the extremes of priestly arrogance with endless ceremonies and the most extravagant dogmatic absurdities." The clerical tyranny of Brahmanism may have been surpassed in papal Rome, and the complexity of its rites in Thibet; but its dogmatic absurdity is *sui generis*, and can really defy competition. "*Credo, quia absurdum videtur*," said the chief theologist of the Patristic era, but the quintessence of the Athanasian confession would seem insipid to devotees who have been fuddled with the opium of Brahma; and Father Huc expressed merely the recognition of a practical impossibility when he advised his countrymen not to send any more missionaries to Hindostan. The clergy, missions, and convents of the Spanish church cost the country a yearly aggregate of forty-two million dollars—after all, less than twenty per cent of the total national revenue—and the emissaries of that church may well shrink from the competition with a priesthood that persuades its constituents to sacrifice *two fifths* of their field-crops to a greedy swarm of four-footed divinities. The hunchback ox (*Bos Bramanus*) enjoys the freedom of every East Indian town. Even Calcutta has its "cow-dung suburbs" (the British soldiers use a stronger term). He defiles the sidewalks, monopolizes the tree-shade, and mingles with the crowd of the market-place. If he collects his perquisites by force, the natives remark that giving is more blessed than receiving; if he knocks them down, they feel with Cardinal Newman that the devotion of the truly faithful shows itself in the endurance of oppressive measures. In every larger city there are walled tanks where sacred crocodiles await the contributions of the pious. In Benares they subsist upon the rent of a real-estate legacy and occasional donations of the wealthy produce-merchants. But even the poorest of the poor contribute to the support of the sacred baboons. The bhunder-baboon and the Hanuman (*Cercopithecus entellus*) have every reason to regard themselves as the primates of the animal kingdom, and man as a humble relative, gifted with certain horticultural talents for the purpose of ministering to the wants of his four-handed superiors. Northern India is dotted with *mahakhunds*, or monkeyfarms, where thousands of long-tailed saints are provided with shelter, respectful attendants, and three substantial meals a day, on the sole condition that they shall renounce their sylvan haunts and bless the neighborhood with the influence of their holy presence. Sick monkeys are sent to the next bhunder-hospital, generally a well-endowed and well-managed institution with a special *dhevadar* or responsible major-domo. The little town of Cawnpore has eight such infirmaries, Benares twenty or twenty-five, some of them with a subdivision for incurables and chronic dyspeptics!

To support these institutions is deemed a privilege as well as a duty. Troops of children, with garlands around their ankles and wrists, march in procession to offer the first-fruits of the season to the major-domos of the next mahakhund. An *embarras de richesse* often obliges that functionary to sell a portion of the donations and invest the surplus in the guarantee funds of the institution. In very poor districts, like Baroda and the northern part of the Madras Presidency, a protracted famine sometimes exhausts these funds, and reduces the *menu* of the sinecurists to two meals a day and half-measures of the weekly treacle allowance, the full rice ration being generally guaranteed by deposit-drafts on a public store-house. At such times, when human beneficiaries would feel grateful for the least assistance, the four-handed *protégés* become peevish. They often abscond and try their luck on the public highways, where orthodox pilgrims would, indeed, part with their last crust rather than disregard the wants of a sacred baboon. If hunger emboldens a low-caste monkey to approach the precincts of a mahakhund, the irate boarders sally forth and pursue him with a rancor as if they suspected him of being accessory to the irregularities of the purveyance system.

When the (Mohammedan) Sepoys destroyed the large monkey-asylum of Behar, the citizens of Nusserabad, though themselves on the verge of famine, promptly organized a relief committee. A provision-wagon, drawn by lean horses and leaner fakirs, drove through the city collecting comestibles, while the conductor of the team, in a sort of sing-song chant, recounted the sufferings of the holy long-tails: "They mourn among the roofless ruins. They sit hungry-eyed, waiting in vain for the arrival of a moderate refection. No bread, no sago-cakes, no rice for the righteous ones, while many a sinner" (with a gleam of suspicion) "regales himself, perhaps, with *yed-na-saccar*" (a sort of blanc-mange). "Their young ones look leaner than scrub-palm lizards. While they fast the just trembles; the eye that looks unmoved may soon be moved by retaliative calamities. Promptly, ye faithful, contribute, contribute!" (C. Ritter's "Travels in Hindostan and Siam," vol. ii, p. 210).

Victor Jacquemont estimates that the Bengal Presidency alone contains sixteen hundred monkey-asylums, supported chiefly by the very poorest class of the population. In the rural districts of Nepaul the hanumans have their sacred groves, and keep together in troops of fifty or sixty adults, and, in spite of hard times, these associations multiply like the monastic orders of mediæval Europe; but they must all be provided for, though the natives should have to eke out their crops with the wild-rice of the Jumna swamp-jungles.

The strangest part of the superstition is that this charity results by no means from a feeling of benevolence toward animals in general, but from the exclusive veneration of a special subdivision of the monkey tribe. An orthodox Hindoo must not willingly take the life of the humblest fellow-creature, but he would not move a finger to save a starving dog, and has no hesitation in stimulating a beast of burden with a dagger-like goad and other contrivances that would invoke the avenging powers of the Society for the Prevention of Cruelty to Animals. Nor would he shrink from extreme measures in defending his fields from the ravages of low-caste monkeys. Dr. Allen Mackenzie once saw a swarm of excited natives running toward an orchard where the shaking of the branches betrayed the presence of arboreal marauders. Some of them carried slings, others clubs and cane-spears. But soon they came back crestfallen. "What's the matter?" inquired the doctor; "did they get away from you?"

"Kapa-Muni," was the laconic reply, "sacred monkeys." Holy baboons that must not be interrupted in their little pastimes. They had expected to find a troop of common makaques, wanderoos, or other profane four-handers, and returned on tiptoe, like Marryat's sergeant who went to arrest an obstreperous drunkard, and recognized his commanding officer. Unarmed Europeans can not afford to brave these prejudices. Captain Elphinstone's gardener nearly lost his life for shooting a thievish hanuman; a mob of raging bigots chased him from street to street till he gave them the slip in a Mohammedan suburb, where a sympathizing Unitarian helped him to escape through the back-alleys. The interference of his countrymen would hardly have saved him, for the crowd increased from minute to minute, and even women joined in the chase, and threatened to cure his impiety with a turnip-masher.

This impiety, say the Brahmans, is merely the effect of ignorance. Foreigners are apt to mistake a hanuman for a common yahoo, a filthy, impudent bush-whacker, while the facts are as follows: The hanuman is a lineal descendant of the great hero-ape who helped the Light-gods in suppressing the power of Ravan, the prince of darkness. The war raged for years with varying success, and the sun-spirits were once almost nonplused, when their long-tailed ally bethought himself of a stratagem that completely discomfited their adversaries: He set the whole Island of Ceylon afire and escaped just in time to attend a grand council of the sun-gods, who then rewarded his services by an hereditary sinecure. In the midst of a solemn war-dance he discovered that his own tail was ablaze, and had to save himself by a hurried trip to the eastern Himalayas, where he extinguished the flames in a lake which to this day bears the name of Bhunder-pouch, or Monkey-tail-pond—a fact which alone suffices to refute the sophisms of narrow-minded skeptics ("Asiatic Researches," vol. xiv, p. 44).

Crocodiles have a prescriptive right to our surplus of non-nitrogenous food, butter, goat-cheese, and the offal of the heretical meat-shops. They are not divine, in a stricter sense, but "water-pure," free from the taint of hereditary sin, and their merits are often rewarded by a quasi-immortality, synchronistic with the duration of this planet. Their peccadilloes must be condoned; the slayer of a *gavial*, or sacred saurian, is an enemy of the public, for his deed is apt to result in a general calamity. In Agra a Buddhistic Chinaman once obtained the post of crocodile-warden, but was soon after arraigned for criminal neglect. A party of foreigners had visited the tank, and a couple of gavials followed them toward the gate, in quest of cold lunch, according to the theory of the prosecution, while the strangers suspected them of homicidal intents, and, finding the gate closed, retreated behind a tree and fired their pistols as fast as they could load. The negligent warden at last interfered, but too late; both crocodiles had been fatally wounded, and one of the victims happened to be a gavial, a most reverend, and, barring *such* accidents, immortal amphibian that had inhabited the tank since the time of Menu. The counsel for the defense not only denied the charge of neglect, but proved that the prehistoric reptile had been imported not more than five years before. The court dismissed the case, and the Chinaman volunteered to pay half the costs, but the Brahmans never forgave him. He lost his place and, like the Rev. Augustus Blauvelt, was accused of having betrayed his master.

The Koran contains some rather incomprehensible ordinances, unless Professor Sale should be right that Mohammed prescribed them as preparatory exercises of faith. The founders of several monastic orders seem also to have thought it necessary to strengthen the orthodoxy of their disciples by periodical renunciations of common sense, but the Brahmans have carried this principle to an even greater length. According to the Yagur-Veda, a spiritual-minded man should renounce the world after following its ways long enough to see the son of his son. To be quite safe, he had better go as soon as his hair begins to get gray. A conscientious *Sannyassi*, or "renouncer," should make his home in the forest, live upon fruits and edible leaves, and let his hair grow. His tunic should consist of bark, his lower garments of untanned antelope-skin. He must elevate his soul by the contemplation of Brahm and humble his body by taking occasional rambles on all-fours. This would be bad enough, but, in order to fulfill all righteousness, a Sannyassi must wear wet clothes in the cold, and pass the midsummer noons between two blazing fires, in order to correct the humors of his spirit. With a view of washing away his worldliness he must not only bathe twice a day, but expose his body to every shower of the rainy season (Weber, "Indische Literatur-Geschichte," p. 395).

Yet this regimen was merely a palliative, prescribed to all refugees from the temptations of this world, and positive sinners had to expiate their guilt by quite different penances. In this higher art of self-torture Buddhism unquestionably bears off the palm of insanity. Under the influence of its dogmas Sannyassism became an elaborate system for weaning the human mind—not from the errors of life, but from life itself, a systematic mortification of all natural instincts and desires, a negative method of suicide. The "renouncer" had first to ascertain his dearest wishes and deliberately thwart them; abandon his friends, relinquish his worldly ambitions, and forego all gratifications of the senses. He next had to avoid whatever could compensate such sacrifices: emulation, fame, and even the pleasures of self-approbation. The candidate of Nirvana had to subsist on insipid food—millet-seed, for instance, or even cresses ("Asiatic Researches," vol. xvii, p. 238). He had to clothe himself in rags, and renounce all worldly possessions, all earthly sympathies; Buddha Ghoska, the South Indian apostle of the great Nepaulese, goes so far as to warn his disciples against sleeping more than once under the same tree, lest their souls should be contaminated with an undue affection for any worldly object (Schopenhauer's "Parerga," vol. i, p. 317). The civil war of contending dogmas filled India with rival hordes of self-torturing fanatics. Brahmans and Buddhists vied in the invention of new torments. Voluntary affliction became the chief criterion of merit. The Buddhistic monasteries practiced the most approved methods for making life hateful and death desirable; among their ghastly penitents all the monsters of La Trappe could have found their prototypes. Troops of Brahmanic flagellants wandered from town to town; the Sannyassis had regular rendezvous, where their novices could profit by the experience of the accomplished lunatics:

> "So gathered they, a grievous company:
> Some day and night had stood with lifted arms,
> Till, drained of blood and withered by disease,
> Their slowly-wasting joints and stiffened limbs
> Jutted from sapless shoulders, like dead forks
> From forest trunks. Others had clinched their hands
> So long and with so fierce a fortitude,
> The claw-like nails grew through the festered palm.
> Certain who cried five hundred times a day
> The names of Shiva, wound with darting snakes
> About their sun-tanned necks and hollow flanks . . .
> Here crouched one in the dust, who, noon by noon,
> Meted a thousand grains of millet out,
> Ate it with famished patience, seed by seed,
> And so starved on; there one who bruised his pulse

With bitter leaves lest palate should be pleased;
And next, a miserable saint, self-maimed,
Eyeless and tongueless, sexless, crippled, deaf."
(EDWIN ARNOLD'S "Light of Asia," p. 18.)

Or Wieland's satirical *résumé:*

"Der Glaube hiess es heilig, wenn
Der Fliegen, der Heuschrecken frass,
Und Jener gar mit seinem heil'gen Hintern
In einem Ameisen-haufen sass,
Um da andachtig zu überwintern."

Nor are those fancy sketches; such things are practiced in Hindostan to this day. Weber estimates the present number of professional Sannyassis at six hundred thousand; De Lanier at six hundred and fifty thousand; and Max Müller even at one million (*vide* "American Cyclopædia," article "Fakir"). The procession of the Juggernaut still frenzies the out-of-the-way villages of the Punjaub; the Brahma-whirlpool at the junction of the Jumna and the Ganges still claims its yearly hecatombs of human victims. In the southwestern presidencies the English Government has at last succeeded in abating the suicidal epidemics; the suttee-rite, for instance, has been effectually suppressed by fining all accomplices and abettors. But the beast-idolatry still flourishes, and bids fair to outlive the British Tract Society, as it has survived the Portuguese *auto-da-fés.* Crocodile-hunters still take their lives in their hands; the hanuman humbug continues to paralyze horticulture, and the most popular argument of the Nana Sahib demagogues was, not the nepotism of the foreign rulers, not the arrogance and partiality of the British bureaucrats, but the "cartridge-grievance": orthodox soldiers, in loading a musket, had been obliged to open with their teeth a pasteboard cartridge that had been greased with a mixture of steatite and *beef-tallow!*

The origin of zoölatry, or beast-worship, in some of its phases, is not easy to explain. The supreme usefulness of black cattle made them the representatives of the *prithivi mâtar*, the benevolent, all-sustaining earth-mother. Crocodiles are invaluable scavengers, and in the granaries of Egypt cats were indispensable enough to deserve an apotheosis. But how did serpents and monkeys come by that honor? In Africa snake-worship marks the lowest stage of "animism," but nearly every nation seems to have passed through that stage. In a very curious account of the customs and superstitions of the Haytian negroes, Mr. Moreau ("History of St. Domingo," by Mr. L. E. Moreau) describes the Voodoo idol as "a serpent supposed to be endowed with the gift of prescience, which it communicates to its favorite attendants, the high-priest and priestess of the Voodoo temple." This superstition Mr. Moreau believes to have been derived from Whydah, in Southern Congo, where the French had a trading-post. But did not the Delphic Pythoness likewise derive her name from a serpent, the great Python of Parnassus, begotten in the ocean-mud of the Deucalian Deluge? The Hebrew word *Ob* is the equivalent of the Grecian *ophis* and the Chaldean *oheb*, a dragon, a serpent; and in the Vulgate the witch of Endor, the "woman who had an *Ob*," is described as a *mulier pythonica;* and the "consulters with familiar spirits" (Deuteronomy, xviii, 11) as "men who worshiped *Ob*," the temple of Bel (a contraction of *Ob-El*, the snake-god) was covered with representations of flying serpents, the wings having been added to indicate the swiftness of the miraculous Python—perhaps the prototype of the Chinese dragon, of our "old serpent," and possibly of the mediæval dragon-myths. On one of the temples of Thebes Belzoni discovered "a row of figures representing three human beings resting upon their knees and with their heads struck off. Before them a serpent-god (*un dio pythonico*) erects his crest on a level with their throats, ready to drink the stream of life as it flows from their veins." Columella, the Roman Huxley, mentions a district of the province of Numidia where the natives tried to break the spell of a summer drought by practicing strange rites with a captive serpent. In the mythology of the Edda the Midgard-snake encircles the globe of the whole earth, and the rupture of its folds will usher in the final return of Chaos. According to Plutarch, the Edonian witches of Thrace practiced their charms by the aid of a tutelary deity in the form of a snake, which they carried from hill to hill in search of a propitious conjuncture of times and places; and among the Veddahs of Ceylon Sir Emerson Tennent ("Ceylon: An Account of the Island, Physical, Historical, and Political") found traces of a very similar superstition; The staff of Æsculapius and the *caduceus* of Mercury were entwined with serpents; and, when the pious Æneas sacrifices at the tomb of his father, the "genius of the sepulchre" emerges in the form of a miraculous snake. The two mysterious strangers who announce the mission of Buddha vanish in the castle-hall, and when the messengers of the king follow them to the gate two furtive serpents glide forth: "The gods come ofttimes thus."

Yet Professor Ritter holds that ophiolatry is the oldest form of demonism or devil-worship, the subtile and deadly serpent being the fittest symbol of the tempter. Barthélemy-Sainte-Hilaire inclines to the opinion that the Egyptian god-serpent was the emblem of immortality, the idea being derived *from the shedding of his skin;* the caves of Elephantine bristle with serpent-heads; and the strangest, but possibly the only correct theory, is Sir W. Jones's conjecture that these shapes are nothing but a modification of that rude symbol of the *vis generativa*—the old Indian phallus.

Monkey-worship is peculiar to Hindostan, and can hardly be explained by the usefulness or the superhuman attributes of poor Hanuman. Yet its antiquity is attested by the sculptures of Ellora and the oldest traditions of the Eastern Aryans. Should it be a sort of inverted anthropomorphism—a typical form of *ancestor-worship?* Dr. Mivart is perhaps right that there were Darwinians before Charles Darwin, who was merely the first systematic exponent of a very ancient doctrine, for the dogma of metempsychosis itself is possibly nothing but a dimly expressed anticipation of the evolution theory.

"Poor creatures, so humble and so sublime," says Lucretius ("*De Natura Rerum*"—published 45 B. C.), "you must now recognize that you are but the first of earthly animals. Your extraction is very base, you have sprung from very low, but by a slow series of efforts you have raised yourself above your inferior, brethren. I know your origin, but I can not see the goal to which you are tending ; yet persevere and work on."

And Buddha :

> "High above Indra's you may raise your lot,
> And sink it lower than the worm or gnat ;
> The end of many myriad lives is this,
> The end of myriads that."

And is it so illogical to believe in the possibility of a metamorphic retrogression, as well as progression? Have not the most godlike nations of antiquity "sunk their lot" very nearly to—and in some respects decidedly below—the level of our simian relatives?

Zoömorphism, as Carl Vogt calls the doctrine of metempsychosis, was taught on the banks of the Ganges before Abraham's father sold his stock-farm at Ur, in Chaldea, and there is no stranger fact in the natural history of religion than the ubiquity of this most ancient and most persistent form of supernaturalism. Its dogmas have tinctured the creed of every nation, and often revive in the most unexpected way. It is the basis of the eighteen Puranas of the Egyptian myths, and the traditions of the elder Edda. The strangely suggestive tales of the metamorphoses were probably borrowed from the religion of prehistoric Italy. The nations of Northern Europe had similar superstitions which still survive the exodus of the Druids. The Christian propagandists could persuade the Saxons and Celts to transfer their devotion from Walhalla to Calvary, but they could not shake their faith in were-wolves, kelpies, and amphibious Melusinas.

"That the creed of Mohammed," says Lecky, "should have preserved its pure monotheism and its freedom from all idolatrous tendencies . . . is a fact which we can only very imperfectly explain." But even the Koran did not eradicate the zoömorphic superstitions of the Southern Semites. Professor Brehm relates that his Bedouin guide implored him in the name of the All-merciful not to fire upon a troop of spotted jackals (*Canis pictus*), as these animals embodied the souls of potent wizards who would cruelly revenge the death of a companion. After the death of Caliph Walid—"El Caffer," the infidel, as the dervishes called him—the citizens of Damascus were frightened by the rumor that the great unbeliever had reappeared in the form of a gaunt hyena that prowled around the city at night; and Abulfeda informs us that before the battle of Aleppo the Karmathians saw a large eagle circling above their vanguard, but were careful not to disturb it, "for they at once recognized the spirit of Abu Taher"—one of their former leaders who had won a great victory on that same battle-field.

Sitting Bull once declared that Father De Smet was the only white man whose word could be implicitly relied upon; but, according to the observations of Mr. W. Everett, this confidence seems to refer to political rather than mythological questions. Mr. William Everett, a government scout at Fort Custer, lived several years among the Sioux, and convinced himself that they believe in the metempsychosis of distinguished chiefs, and on one occasion he saw Sitting Bull himself "making motions with his hands, and talking to a large wolf, which apparently understood what he said, for, whenever he made the sign for 'Do you understand?' the wolf would throw up his head and howl." They deem it unlucky to kill a white wolf (like the Laplanders, who entertain similar scruples in regard to the white polar fox), and only famine will induce them to shoot at a white-tailed deer. During the hard winter of 1865 six young braves took the risk, and, "were found strangled with marks of fingers on their throats and horrified looks, as if they had seen something awful" (*vide* "Popular Science Monthly," vol. xxi, p. 422).

The Tyrolese mountaineers have an equally weird superstition which their priests have not seen fit to discourage, namely, that an unbaptized child is changed into a Flüh-vogel (a bird with a peculiar wailing cry), and has for ever to flit about the desolate shores of the highland lakes; and the Albanian peasants believe that Constantin Kastro, the companion in arms of the famous Scanderbeg, still haunts his native mountains in the form of a black falcon.

[*To be continued.*]

THE GOSPEL OF RECREATION.

By HERBERT SPENCER.

ADDRESS AT HIS FAREWELL BANQUET, NOVEMBER 9TH.

MR. PRESIDENT AND GENTLEMEN: Along with your kindness there comes to me a great unkindness from Fate; for, now that, above all times in my life, I need full command of what powers of speech I possess, disturbed health so threatens to interfere with them that I fear I shall very inadequately express myself. Any failure in my response you must please ascribe, in part at least, to a greatly disordered nervous system. Regarding you as representing Americans at large, I feel that the occasion is one on which arrears of thanks are due. I ought to begin with the time, some two-and-twenty years ago, when my highly-valued friend Professor Youmans, making efforts to diffuse my books here, interested on their behalf the Messrs. Appleton, who have ever treated me so honorably and so handsomely; and I ought to detail from that time onward the various marks and acts of sympathy by which I have been encouraged in a struggle which was for many years disheartening. But, intimating thus briefly my general indebtedness to my numerous friends, most of them unknown, on this side of the Atlantic, I must name more especially the many attentions and proffered hospitalities met with during my late tour, as well as, lastly and chiefly, this marked expression of the sympathies and good wishes which many of you have traveled so far to give, at great cost of that time which is so precious to the American. I believe I may truly say that the better health which you have so cordially wished me will be in a measure furthered by the wish; since all pleasurable emotion is conducive to health, and, as you will fully believe, the remembrance of this event will ever continue to be a source of pleasurable emotion, exceeded by few, if any, of my remembrances.

And now that I have thanked you, sincerely though too briefly, I am going to find fault with you. Already, in some remarks drawn from me respecting American affairs and American character, I have passed criticisms which have been accepted far more good-naturedly than I could reasonably have expected; and it seems strange that I should now again propose to transgress. However, the fault I have to comment upon is one which most will scarcely regard as a fault. It seems to me that in one respect Americans have diverged too widely from savages. I do not mean to say that they are in general unduly civilized. Throughout large parts of the population, even in long-settled regions, there is no excess of those virtues needed for the maintenance of social harmony. Especially out in the West, men's dealings do not yet betray too much of the "sweetness and light" which we are told distinguish the cultured man from the barbarian. Nevertheless, there is a sense in which my assertion is true. You know that the primitive man lacks power of application. Spurred by hunger, by danger, by revenge, he can exert himself energetically for a time; but his energy is spasmodic. Monotonous daily toil is impossible to him. It is otherwise with the more developed man. The stern discipline of social life has gradually increased the aptitude for persistent industry; until, among us, and still more among you, work has become with many a passion. This contrast of nature has another aspect. The savage thinks only of present satisfactions, and leaves future satisfactions uncared for. Contrariwise, the American, eagerly pursuing a future good, almost ignores what good the passing day offers him;

and, when the future good is gained, he neglects that while striving for some still remoter good.

What I have seen and heard during my stay among you has forced on me the belief that this slow change from habitual inertness to persistent activity has reached an extreme from which there must begin a counter-change—a reaction. Everywhere I have been struck with the number of faces which told in strong lines of the burdens that had to be borne. I have been struck, too, with the large proportion of gray-haired men; and inquiries have brought out the fact that with you the hair commonly begins to turn some ten years earlier than with us. Moreover, in every circle I have met men who had themselves suffered from nervous collapse due to stress of business, or named friends who had either killed themselves by overwork, or had been permanently incapacitated, or had wasted long periods in endeavors to recover health. I do but echo the opinion of all the observant persons I have spoken to, that immense injury is being done by this high-pressure life—the physique is being undermined. That subtle thinker and poet whom you have lately had to mourn, Emerson, says, in his essay on the gentleman, that the first requisite is that he shall be a good animal. The requisite is a general one—it extends to the man, to the father, to the citizen. We hear a great deal about "the vile body"; and many are encouraged by the phrase to transgress the laws of health. But Nature quietly suppresses those who treat thus disrespectfully one of her highest products, and leaves the world to be peopled by the descendants of those who are not so foolish.

Beyond these immediate mischiefs there are remoter mischiefs. Exclusive devotion to work has the result that amusements cease to please; and, when relaxation becomes imperative, life becomes dreary from lack of its sole interest—the interest in business. The remark current in England, that, when the American travels, his aim is to do the greatest amount of sight-seeing in the shortest time, I find current here also: it is recognized that the satisfaction of getting on devours nearly all other satisfactions. When recently at Niagara, which gave us a whole week's pleasure, I learned from the landlord of the hotel that most Americans come one day and go away the next. Old Froissart, who said of the English of his day that "they take their pleasures sadly after their fashion," would doubtless, if he lived now, say of the Americans that they take their pleasures hurriedly after their fashion. In large measure with us, and still more with you, there is not that abandonment to the moment which is requisite for full enjoyment; and this abandonment is prevented by the ever-present sense of multitudinous responsibilities. So that, beyond the serious physical mischief caused by overwork, there is the further mischief that it destroys what value there would otherwise be in the leisure part of life.

Nor do the evils end here. There is the injury to posterity. Damaged constitutions reappear in children, and entail on them far more of ill than great fortunes yield them of good. When life has been duly rationalized by science, it will be seen that among a man's duties care of the body is imperative, not only out of regard for personal welfare, but also out of regard for descendants. His constitution will be considered as an entailed estate, which he ought to pass on uninjured if not improved to those who follow; and it will be held that millions bequeathed by him will not compensate for feeble health and decreased ability to enjoy life. Once more, there is the injury to fellow-citizens, taking the shape of undue disregard of competitors. I hear that a great trader among you deliberately endeavored to crush out every one whose business competed with his own; and manifestly the man who, making himself a slave to accumulation, absorbs an inordinate share of the trade or profession he is engaged in, makes life harder for all others engaged in it, and excludes from it many who might otherwise gain competencies. Thus, besides the egoistic motive, there are two altruistic motives which should deter from this excess in work.

The truth is, there needs a revised ideal of life. Look back through the past, or look abroad through the present, and we find that the ideal of life is variable, and depends on social conditions. Every one knows that to be a successful warrior was the highest aim among all ancient peoples of note, as it is still among many barbarous peoples. When we remember that in the Norseman's heaven the time was to be passed in daily battles, with magical healing of wounds, we see how deeply rooted may become the conception that fighting is man's proper business, and that industry is fit only for slaves and people of low degree. That is to say, when the chronic struggles of races necessitate perpetual wars, there is evolved an ideal of life adapted to the requirements. We have changed all that in modern civilized societies, especially in England, and still more in America. With the decline of militant activity, and the growth of industrial activity, the occupations once disgraceful have become honorable. The duty to work has taken the place of the duty to fight; and in the one case, as in the other, the ideal of life has become so well established that scarcely any dream of questioning it. Practically, business has been substituted for war as the purpose of existence.

Is this modern ideal to survive throughout the future? I think not. While all other things undergo continuous change, it is impossible that ideals should remain fixed. The ancient ideal was appropriate to the ages of conquest by man over man, and spread of the strongest races. The modern ideal is appropriate to ages in which conquest of the earth and subjection of the powers of Nature to human use is the predominant need. But hereafter, when both these ends have in the main been achieved, the ideal formed will probably differ considerably from the present one. May we not foresee the nature of the difference? I think we may. Some twenty years ago, a good friend of mine and a good friend of yours, too, though you never saw him, John Stuart Mill, delivered at St. Andrews an inaugural address on the occasion of his appointment to the Lord Rectorship. It contained much to be admired, as did all he wrote. There ran through it, however, the tacit assumption that life is for learning and working. I felt at the time that I should have liked to take up the opposite thesis. I should have liked to contend that life is not for learning, nor is life for working, but learning and working are for life. The primary use of knowledge is for such guidance of conduct under all circumstances as shall make living complete. All other uses of knowledge are secondary. It scarcely needs saying that the primary use of work is that of supplying the materials and aids to living completely; and that any other uses of work are secondary. But in men's conceptions the secondary has in great measure usurped the place of the primary. The apostle of culture, as it is commonly conceived, Mr. Matthew Arnold, makes little or no reference to the fact that the first use of knowledge is the right ordering of all actions; and Mr. Carlyle, who is a good exponent of current ideas about work, insists on its virtues for quite other reasons than that it achieves sustentation. We may trace everywhere in human affairs a tendency to transform the means into the end. All see that the miser does this when, making the accumulation of money his sole satisfaction, he forgets that money is of value only to purchase satisfactions. But it is less commonly seen that the like is true of the work by which the money is accumulated—that industry, too, bodily or mental, is but a means, and that it is as irrational to pursue it to the exclusion of that complete living it subserves as it is for the miser to accumulate money and make no use of it. Hereafter, when this age of active material progress has yielded mankind its benefits, there will, I think, come a better adjustment of labor and enjoyment. Among reasons for thinking this, there is the reason that the process of evolution throughout the organic world at large brings an increasing surplus of energies that are not absorbed in fulfilling material needs, and points to a still larger surplus for humanity of the future. And there are other reasons which I must pass over. In brief, I may say that we have had somewhat too much of the "gospel of work." It is time to preach the gospel of relaxation.

This is a very unconventional after-dinner speech. Especially it will be thought strange that in returning thanks I should deliver something very much like a homily. But I have thought I could not better convey my thanks than by the expression of a sympathy which issues in a fear. If, as I gather, this intemperance in work affects more especially the Anglo-American part of the population—if there results an undermining of the physique not only in adults, but also in the young, who, as I learn from your daily journals, are also being injured by overwork—if the ultimate consequence should be a dwindling away of those among you who are the inheritors of free institutions and best adapted to them—then there will come a further difficulty in the working out of that great future which lies before the American nation. To my anxiety on this account you must please ascribe the unusual character of my remarks.

And now I must bid you farewell. When I sail by the Germanic on Saturday, I shall bear with me pleasant remembrances of my intercourse with many Americans, joined with regrets that my state of health has prevented me from seeing a larger number.

THE INFLUENCE OF EDUCATION ON OBSERVATION.

It was lately remarked in these columns that one of the dangers attendant on education was that it might lessen men's powers of observation. There is no doubt, we apprehend, that this possibility does exist. Bookishness and absence of mind are no new faults among students. Among the more cultivated classes they have, indeed, been for a considerable time in process of diminution, and the last half-century more particularly has seen a great change in this respect. Physical science has roused students, who in former ages would have been abstract thinkers and nothing more, to careful and steady observation of external things. Facilities of traveling have acted as another stimulus in the same direction; and the love of nature has been a power over sentimental minds, and has led them insensibly from a quiet enjoyment of their surroundings to more active investigation. So that altogether the classes which at the present day have the advantage of the higher education are far more observant than were their forerunners of three or four centuries ago; and, though even now many of the mathematicians and philosophers who walk the streets of our universities live largely in a mood of abstract thought, we must be careful of finding undue fault with this, for the inward eye has some claims not lightly to be despised. But, with respect to the mass of the nation, the question we have raised is one that deserves a good deal of attention. Popular education is still in the bookish stage; and, without complaining of what is inevitable, we may and ought to inquire whether literary study does now in the lower ranks promote that vice of inobservance which it certainly promoted in the higher ranks a century or two ago. Equally we have to inquire whether the virtue which is the converse of this error may be fostered; whether and how the study of books may be made to minister to powers of direct observation, instead of being adverse to them, and to assist in the general business of life.

Literary study may conceivably impede our observant faculties, either by suggesting problems that appear to demand pure thinking alone for their solution, or by imbuing the mind with an ambitious tone, in which the ordinary events of every-day experience are looked upon as unworthy of notice. In the latter case it must be acting mischievously; in the former case it may be mischievous, though it is not always so. If a problem is really of a purely abstract character, it is inevitable that external observation should be lulled during the investigation of it. Newton was in many respects an inobservant, absent-minded man; but without that inobservance he could not have been the master of abstract thought that he was, or have made the discoveries that have been so powerfully beneficial to the human race. But there are many problems which have an appearance of being abstract, and soluble by pure thought alone, in which this is by no means really the case. Questions of ethics, of political economy, of art, are of this nature; they have a delusive appearance of abstraction from the actual world in which we live; and many an inquirer has gone round and round in them in a profitless circle, without being aware that the element needed to render him successful was not brain-power at all, but experience of men and things. The danger, however, that the faculties of observation may be blunted by an excess of abstract thought is not very great in the popular education of the present day. But the danger that they may be blunted by mistaken ambition is a real one. The clever and educated poor will at times despise the common incidents of daily life, in comparison with that larger sphere to which books give them an introduction in imagination, though not in reality. Housekeepers find that servants neglect the pots and pans and dishes, can not find anything when it is wanted, can not see cobwebs in the corners or dust upon the shelves and tables, while their attention is devoted to the pleasures of literature in some, very often questionable, form. Farmers, we have been told, complain of the degeneracy of plowboys from the same cause. True, farmers are a complaining race, and their misfortunes of late years may have made them more querulous than usual; but their testimony should not be quite disregarded. Some considerable application of the maxim that people should do their duty in their own station will be found to give no unneeded help to the observant faculties at a time of large general progress, when hopes and ideas are apt to be extensive and vague.

But it is not enough that education should refrain from hindering the faculties of observation; it ought, if it is sound, actually to promote and enlarge those faculties. How this may be done is a problem not without difficulty. While the fault of inobservance is simple and single in its nature, the virtue of ready observation is complex, relating to many different spheres; he who possesses it in one sphere may lack it in another. When Thales, looking at the stars, tumbled into a well that lay before his feet, he was partly very inobservant, partly very observant ; by the one quality he doubtless incommoded himself grievously, by the other he discovered how to predict eclipses, saved mankind from a certain amount of irrational panic, and won for himself a great reputation. To Thales the balance was for good ; but it would not be safe to affirm that this would be the case with every one who walked with his head in the air looking at the stars.

Thus the direction in which observation may be most usefully practiced varies with the circumstances of the case ; with the circumstances of the pupil when education is in question ; and is not the same in the different ranks of society. The problem has, we think, been most successfully solved at present in the colleges, more or less recently founded, of our great northern towns. There, physical science is in demand for practical purposes, and educational institutions accommodate themselves to the demand. But, in the elder universities and the elementary schools alike, an equal measure of solution has not yet been attained. Oxford and Cambridge students (to begin with the higher rank) have not, as a rule, any plain and visible necessity for physical science as an aid in their future employments. But there is another side of science besides the immediately practical one—a side which ought to be held of especial value in institutions that have under their survey the largest interests of humanity. The great sciences of observation—astronomy, geology, and the natural history of animals and plants—are more noticeable for their ideal than for their practical side, though they do touch on practice also. They give sublime views of the universe, such as it is a refreshment and consolation to possess, and such as touch not remotely on the destiny and happiness of man. We in England, at any rate, are not hopeless of the reconciliation of these views with the religious ideal that we have received. But it is the apparent collision, on certain points, between the new and the old that has impeded the reception of these sciences in those respects in which they are so calculated to elicit human feeling, and therefore so appropriate as studies in our elder and chief universities. In astronomy, indeed, the collision with religion has been long ago practically surmounted. But the observational side of astronomy has been rather sunk at Cambridge and Oxford in comparison with its mathematical side. It may be suspected that many students of astronomy (though not astronomers proper) have less knowledge of the actual face of the heavens than had those Chaldean shepherds who roamed the plains of the East thousands of years ago, in whom the science originated.

When we come to the poorer extreme of society, though the elementary education of the country does not quite ignore the cultivation of the observant faculties, neither does it, in our opinion, lay sufficient stress upon them. The arts of reading and writing, and the study of arithmetic, taken simply by themselves, have a tendency to withdraw the mind from the outer world, and it needs a corrective to restore the balance. That corrective may, in certain cases, be supplied by the subject-matter of the books read, if it is required that they shall be intelligently understood. At the same time, such a requirement must be very positive and direct in order not to be evaded. Though the Education Department does at the present moment require from children in elementary schools, not merely an intelligent style of reading, but also (in the upper standards) an acquaintance with the subject-matter of the books read, it would naturally be felt to be extremely hard that a child should be declared to have failed in reading because he or she showed a want of proper observation. But we should like to see this whole topic of intelligent acquaintance with the subject-matter of the books read removed from the mere art of reading, and constituted into a separate subject by itself—say into a class subject, such as geography and grammar are now. If this were done, it would not be hard upon a child to demand from it some amount of observation as well as intelligence. If, for instance, the reading-book referred to any agricultural operation, such as harvesting, or to some well-known plant or flower or vegetable, or to cattle, or to birds, whether migratory or permanent in the country, then in a country school the children might fairly be questioned so as to bring out what they themselves had observed on these matters. In a town school questions might be asked on other matters to which reading-books would also now and then make reference—railways, stations, the different public buildings and their uses, the trades or manufactures specially practiced in the town. We can not but think that there is a real gap in the training of children in the poorer classes, and that the step we here recommend might do much to fill it.

It is true, and we note the fact with pleasure, that the Education Department has of late encouraged methods of teaching geography which bring out that side in which it is connected with direct observation. The suggestion that in every school the meridian line should be marked on the floor, in order that the points of the compass may be practically known, is a valuable one in this direction. Still more so is the suggestion, almost amounting to a requirement, that "good maps of the parish or immediate neighborhood in which the school is situated should be affixed to the walls." But of course the value of these appliances depends on the way in which they are used. The meridian line may be marked with exactness, the map of the parish may be unexceptionable, but if the knowledge of these points is not interwoven with the daily teaching it will be fruitless. And we can not but regret that the Education Department should treat geography as a subject inferior in importance to grammar. This is to place the abstract before the concrete, which is contrary to all natural and true method. We are sure that it needs far greater skill to render a grammar-lesson really fruitful and beneficial than to render a geography-lesson so. When grammar is made almost a necessity, while geography is distinctly not a necessity, how is it possible but that geography must go to the wall? There is, indeed, another class subject recognized by the Education Department in their New Code which would cultivate observation even more, perhaps, than geography does—namely, elementary science. But we presume it is the opinion of the Department itself (as it certainly is our own) that this subject will not be largely used; for, in the recently issued "Instructions to Inspectors" it is passed over very cursorily, without the least indication as to the parts of natural science to be preferred, or any more than the vaguest as to methods. Elementary science will have a very uphill battle to fight if it is to win any real recognition, where the recognition of it involves the discarding of the more familiar geography, which by the terms of the Code it does. But our fear is that geography and elementary science will alike play but a poor part, in view of the superior importance and extended meaning given to grammar in the New Code. And, while some of the "specific subjects" of the Code are such as would encourage the observant faculties, these subjects are taken up by so small a number of children as hardly to affect the broad question we are discussing.

A suggestion, however, has been made which, if it could be carried out, would undoubtedly bring popular education into more direct relations with the external world, and therefore encourage the observant faculties more than is the case at present. This is that, just as girls are taught needle-work, so boys should in the course of their education be taught some elements of their future practical work in life. This has especially been urged in the interests of agriculture, and it has been thought that boys might be taught, while still at school, so much of the rudiments of farming as would greatly improve their future capacity. Of this proposal we can only say that we should be glad if it could be found practicable, but we are afraid the difficulties of connecting practical farming with school-work would be found very great. It might be easier to bring gardening into the school routine. But all that can here be said is that this suggestion, like all others that tend to relieve popular education from mere formalizing, deserves attention; and that, if the difficulties which it appears to present could be got over, it would certainly be a great benefit to the country.—*Saturday Review.*

SPECULATIVE ZOÖLOGY.

By Professor W. K. BROOKS,
OF JOHNS HOPKINS UNIVERSITY.

II.

WE will now examine our various sources of information, in order to see how far the evidence which they furnish can be used to establish phylogenies.

Comparative anatomy might not at first sight be expected to yield much of this kind of evidence, for the only animals which we can study thoroughly are those recent ones which have diverged very widely from their remote ancestors; and, while it is true that the study of the structure of living animals does not furnish direct evidence, the doctrine of homology supplies a means of sifting out, by general comparisons, what has been recently acquired from what is more deep seated, and of thus arranging animals in a series of groups of greater and greater extent and less and less contact. This classification of animals upon morphological grounds is essentially phylogenetic, for the difference between a system of converging lines and a system of more and more inclusive definitions is simply a difference in the manner of expression; nor can it be said that the one method assumes the disputed point, genetic relationship, any more than the other, for the naturalist who believes that classification is not simply a matter of convenience, but that there is one natural system, and that, according to this system, living things fall into a few great groups, each of which is characterized by certain general features, and that each of these groups is divided into smaller groups distinguished in a similar way, and these again into smaller groups, and so on, tacitly assumes that the natural system of classification or relationship is what we should expect it to be if the theory of descent with modification is true.

If there is a natural "systematic classification," it must be exactly the same as a phylogenetic tree, and the idea of descent is no more essential in the one case than it is in the other; they are simply different ways of expressing the same thing, the relationship of living things, and neither of them involves more than the other any particular interpretation of the word relationship; nor can it be said that, while the one method assumes that the larger trunks of the system have at some time been embodied in actual organisms, the second method allows us to believe that these groups are purely ideal, for, although this latter conception may have been defensible to some extent in the early days of morphological science, the progress of discovery has shown that even nowadays animals exist in which the characteristics of a branch or of a class or order are exhibited in their simplicity, and uncomplicated by the presence of the characteristics of any of the minor divisions of the group: thus amphioxus is a generalized or diagrammatic vertebrate, with structural features which are common to the whole group, and none of the distinctive marks of any of the great subdivisions of the group. In a phylogenetic tree such a form would be represented by a line running almost directly upward from a point where great branches diverge from a common stem; and the fact that these generalized forms are much more often found among fossil than among recent animals is very suggestive.

This short analysis is sufficient to show that the essential similarity between a system of classification based on homology and a phylogenetic tree is so great that all objections to the one method of generalizing from the facts must apply to the other. If phylogenetic speculations retard science, speculations upon homology must do the same thing, and the only way to avoid danger will be to stick to facts, and, stripping our science of all that renders it worthy of thinking men, to become mere observing machines.

As it is plain that the strictest construction of the proper scope and limits of scientific thought does not make any such demands as this, we may feel at liberty to speculate upon phylogeny with such a basis as is furnished by the comparative study of the systematic relationship of living animals, but we are not able to go very far in this direction, for nearly all living animals fall into a few great well-defined groups, and generalized types are the exception. Our conclusions must, therefore, be very vague and general, and we turn to the paleontological record for more exact data; but here, again, we soon meet with limitations which prevent any very exact and definite generalizations. One of these limitations, the imperfection of the record, we have already examined, and another is due to the fact that most of the main stems of the phylogenetic tree, and the minor branches of many of them, were established before the time of the oldest fossiliferous rocks, and we can not hope to find fossil remains of the unspecialized ancestors from which they were derived. This renders it hopeless for us to attempt actual proof of the more deep-seated phylogenetic relationships; and another consideration, which we will now examine, renders the discovery of the exact relationship of smaller groups of genera and species almost equally hopeless, even when the most ample series of fossils is discovered.

All that we know of variation indicates that it is not induced in the adult, but that it is congenital, and the effect of some force which has acted upon or through the parents. Hence it happens that, when a new variety is produced, it is not usually by the addition of something new to the characteristics of a mature animal, but by a divergence which shows itself before maturity is reached. When we compare two closely related species or varieties of birds, we do not find that one is like the other with additions, but we find that the young are alike up to a certain point, where the divergence of the adults begins. If the letter A, in diagram 2, represents an adult animal, and the series of dots in the vertical line a few of the stages of its development between birth and maturity, the relationship between A and a closely allied species, B, would not usually be of such a kind that it could be expressed by the line A B, but by a line B *c*, running back to a younger stage of A. Since the duration of mature life is usually much longer than the period of development, adults are generally more numerous than young individuals, and, as their hard parts are in most cases more fully developed, there is a much greater chance of finding adult than young specimens of fossil species. Even if we should find in a recent geological formation the adult fossil ancestor A of a recent species B, the agreement between the two would be inexact, and could not be fully perceived until we had compared a number of stages in the development of B with corresponding stages in the development of A; and a reference to diagram 2 will show that the actual relationship of B to still another species, D, might be just as close as its relationship to A, although B might be much more different from D than from A. The complexity of the case would be still further increased if D were met with in a more recent stratum than that which yielded A, and in this case the preservation, discovery, and identification of three distinct sets of young forms would be necessary before the relationships of A, B, and D could be unraveled. In nature few cases are so simple as this, and, where a dozen species are involved, the complexity would be so great that no one who has had any practical acquaintance with the difficulty of identifying immature animals with certainty, without rearing them, could have any hope of complete, exact, and definite evidence of phylogeny from fossils.

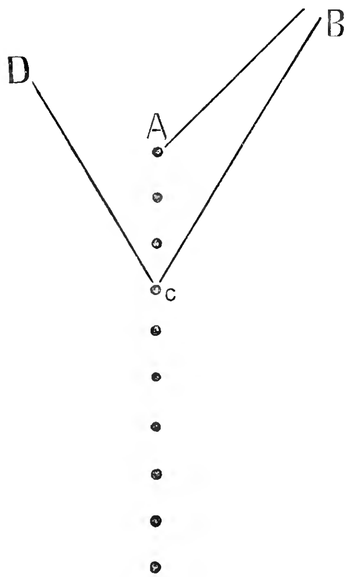


Fig. 2.

While this is true in every case, its truth is most obvious where animals have become adapted to new conditions of life, not by the acquisition of new specializations of structure, but by the loss of old ones. The occurrence of unquestionable cases of simplification, or what is usually called *degradation*, is well known to naturalists, but, as these cases are not so well known to the unscientific public as their significance in any general theory of life demands, a short account of one of the less complex instances will not be out of place.

Entoconcha is an extremely simple, worm-like animal, which lives, as a parasite, inside the body of an holothurian. It is fastened, by a button-like head, into a perforation in the wall of the digestive tract of the holothurian in such a way that, while its mouth opens into the digestive cavity, its long, contorted body hangs in the body cavity of its host, so that it is bathed by its fluids, and protected by its body-wall. As the digested food passes by its mouth the animal sucks it into its rudimentary stomach, and, as all its wants are thus provided for, the conditions of its life are extremely simple, and its bodily structure exhibits a corresponding simplicity, and it may be described as a long, cylindrical, worm-like animal, with a simple, pouch-like stomach which opens by the mouth at the anterior end, and occupies about one half the length of the body, while the other half is filled by the equally simple organs of reproduction. It is as lowly organized as the simplest of parasitic worms, and it is only by a study of its development that we learn it is not a worm at all, but a gasteropod mollusk, which has become degraded or simplified to adapt it to a parasitic life. The ordinary gasteropods, the snails, conchs, etc., are animals of quite high organization. They are usually provided with a protecting shell, and their organs of locomotion are well developed. In connection with a specialized muscular system, they possess a well-marked and complex nervous system, as well as sense-organs, such as eyes, tentacles, and hearing organs. The digestive organs are quite highly specialized, and consist of parts which bear a close physiological resemblance to those of a vertebrate. The food is masticated by a very complicated system of jaws and teeth, and after it has been mixed with a secretion, which is poured into the mouth by salivary glands, it passes through a long muscular œsophagus into the stomach, where it is acted upon by fluids furnished by a liver and other glands, before it passes into the long, convoluted intestine, where the nutritive portions are absorbed into the blood, while the waste products are discharged from the body through the anus. The nutritive matter is driven to all parts of the body, with the blood, through a system of arteries and veins, by a pulsating heart, and during a part of its course the blood passes through respiratory organs, where it is aërated by contact with the air or water. The waste products are excreted from the blood by renal organs, and the organs of reproduction are extremely complicated and highly specialized.

The animal which has been seen to hatch from the egg of entoconcha is a young gasteropod, which, like the young of ordinary forms, has a spiral shell, a muscular locomotor foot, tentacles, eyes, hearing organs, and a nervous system like that of other gasteropods at the same stage of growth. The digestive tract is divided into regions, like those of an ordinary gasteropod, and the young entoconcha has no peculiarities to indicate that the structure and habits of the adult are to be in any way strange or unusual ; but after a time it finds its way, in some manner which has not been clearly made out, into the body of an holothurian, and this change in its habits is accompanied by a most marvelous change in its organization. It now has no shell, since the body-wall of its host affords ample protection, and, as it no longer needs to change its position in search of food, or to escape its enemies, its foot and specialized muscles have disappeared. Its organs of sense are wanting, and the nervous system is so rudimentary that no traces of it can be discovered. It has no need of organs to capture, masticate, or digest its food, since it sucks this, already digested, from the stomach of its host, and its digestive system has accordingly become reduced to a simple pouch, with only one opening—the mouth—and, as the whole surface of the body is bathed by the blood which is aërated in the respiratory organs of the holothurian, it has no need for gills, or heart, or blood-vessels, and, so far as our knowledge goes, these organs are entirely lacking.

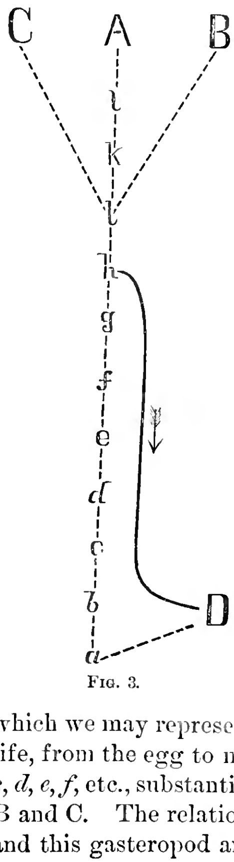


Fig. 3.

Of the highly specialized organs of a gasteropod only the simple stomach, the reproductive organs, and the slightly muscular body-wall remain, and no person who is not acquainted with the fact that young snails with spiral shells have been seen to come from its eggs would suspect that entoconcha is a mollusk.

Such cases, which modern research has proved to be by no means infrequent, show that the comparative study of adult animals can not furnish a complete key to their past history, and they also illustrate how little is to be hoped for from paleontology.

No one who accepts the doctrine of descent with modification, and is familiar with the embryology of the gasteropods, can doubt that, if we were able to trace back the pedigree of entoconcha, we should be led to a remote ancestor which was an ordinary gasteropod ; not necessarily a species exactly like any we know, but a form with general gasteropod characteristics at least : nor can we doubt that, if we were able to study the embryology of this ancestral form, which we may represent by the letter A in diagram 3, we should find its life, from the egg to maturity, to be made up of a series of stages, *a*, *b*, *c*, *d*, *e*, *f*, etc., substantially like stages in the life of ordinary gasteropods, B and C. The relation between the entoconcha of the present day, D, and this gasteropod ancestor, is shown by the curved line to D. Starting with the egg, the young entoconcha passes through a series of stages, *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, which are like stages in the development of an ordinary gasteropod, and therefore like stages in the life of its gasteropod ancestor, A; but, after reaching a certain point, it takes the back track shown by the unbroken line, and, gradually losing the structural complexity which has been acquired, becomes an adult, D, which has reproductive organs, but is, in other respects, as unspecialized as an ordinary gasteropod at one of its earliest embryonic stages, *b*.

It is obvious that paleontology can give us little help in tracing out such a life-history as this, and we turn to the remaining source of evidence, embryology, to examine how far the facts furnished by this department of life-science can afford a basis for phylogenetic generalizations.

The case which we have just examined shows that the embryology of two related forms may be essentially the same, since both of them have inherited the greater part of their life-history from a common parent, and it would seem at first sight as if all that we need, to enable us to trace out the relationship of all living animals, is a complete acquaintance with the embryology and metamorphosis of each one of them. A comparison of all the stages in the life of one species with all the stages in the life of another species of the same genus ought to show essential identity; and a comparison of the stages of development of the species of one genus with those of the species of a related genus ought to show how far their history has been the same: the common features in the embryology of two allied families should show how far the history of the species in one of them has been the same as that of the species in the other, and so on, each wider and wider comparison showing broader and broader relationships, until the features which are common to the embryos of all animals unite them into one great group.

As this may be clearer in a more abstract shape, I will try to state it in the form of a diagram (see Fig. 4).

Suppose that, in studying the development of four species, 1, 2, 3, 4, we find that 1 passes through a series of stages, *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*; that 2 presents the series *a*, *b*, *c*, *d*, *e*, *f*, *i*, *j*, *k*; while 3 passes through the stages *a*, *b*, *c*, *l*, *m*, *n*, *o*, *p*, *q*; and 4 through the stages *a*, *b*, *c*, *l*, *m*, *r*, *s*, *t*, *u*. A comparison of these four life-histories would indicate that their common relationships are such as are represented by the four-branched tree shown in Fig. 4. We have already seen that it is perfectly possible that *n* or *c* or *e* may not have been an adult animal, but simply a stage in the development of an unknown adult, *x*; so there would not be much chance of finding *m* or *e* or *c* as a fossil, and the embryonic record would not show us what the common ancestor of 1 and 2 or the more remote ancestor of all four species actually was, but would simply show that they are related in this way; but it would show this relationship as conclusively as the vertebrate relationship of birds and mammals is shown by the presence of a backbone in each of them. It will be seen that the facts in this imaginary case belong to the same category with the facts of homology, but that they

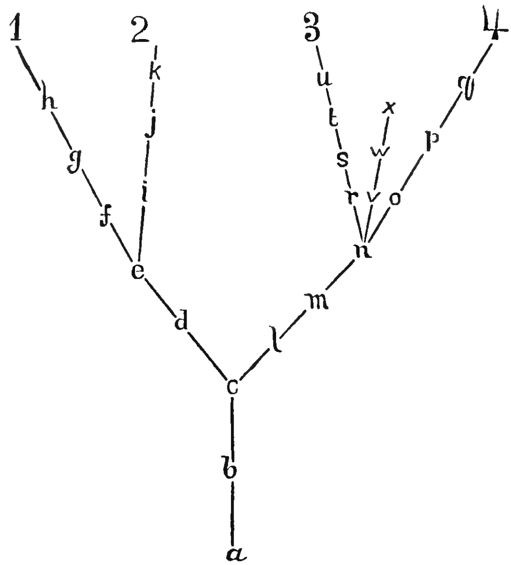


Fig. 4.

furnish a much more complete index of relationship, since they cover the whole life of the animal, instead of its adult form alone.

As a matter of fact we do find in nature something like this hypothetical case, and it is universally recognized that an acquaintance with all the stages in the growth of an animal is the greatest aid to the discovery of its true affinities; as is well shown by the case of entoconcha, and by the barnacles which were classed among the mollusca until a knowledge of their development showed that they are crustacea. When descriptive embryology was in its infancy, it so frequently happened that a knowledge of younger stages threw a flood of light upon the affinities of doubtful forms, that naturalists felt a growing hope that here was the true key to the natural system of classification, and that all they needed for reading the riddle was a thorough knowledge of the whole course of development of each form of life. If the embryology of each animal were a fixed quantity, this purely descriptive knowledge would undoubtedly furnish such a basis for phylogenetic generalizations; but the great advances which have been made in this field within the last twenty years show conclusively that this is not the case, but that the early stages in the life of an animal may undergo modifications which are quite independent of any which may meanwhile take place in the adult, so that, while the paleontological record is faulty through incompleteness, that of embryology is faulty through distortion and secondary modification. In general we do find the young stages of related species more like each other than the adults, and the distinctive characteristics of each are usually acquired gradually during the process of development; but this rule is by no means universal, and there are very many cases in

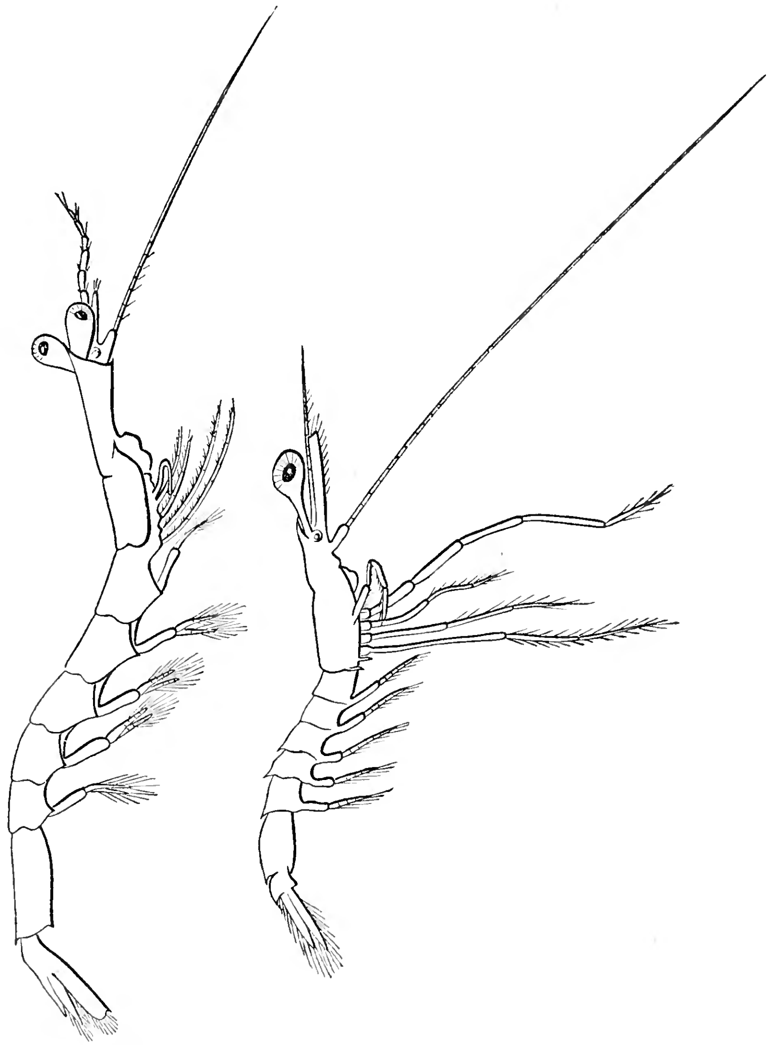


FIG. 6. FIG. 5.

which the adults of related species are more alike than the young, and in some cases the difference between the young forms is so great that their close relationship would hardly be suspected until each had been traced to its adult form; and we have the converse of the case of entoconcha where the true affinities of a greatly modified adult are shown by its younger stages.

I give four figures to illustrate one such instance, which is not by any means exceptional or extreme; and in certain groups of animals, such as the crustacea, such cases are quite numerous.

Fig. 5 is a magnified side-view of a crustacean, Sergestes, which is not quite full grown, but still essentially like the adult; and Fig. 6

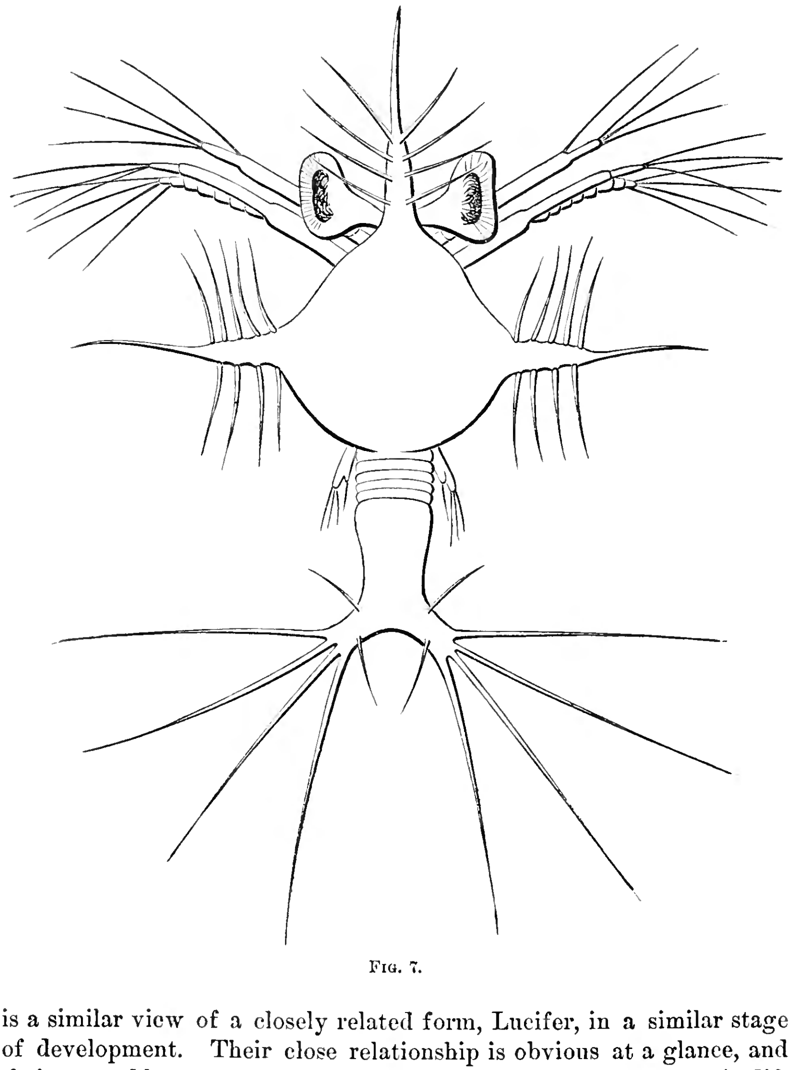


FIG. 7.

is a similar view of a closely related form, Lucifer, in a similar stage of development. Their close relationship is obvious at a glance, and their resemblances, which are much more conspicuous than their differences, are rendered more obvious by careful study; but the case is quite different when the younger stages are compared, and at first sight no one would suspect that the Sergestes larva (Fig. 7) and the Lucifer larva (Fig. 8) are corresponding stages in the development of two animals as similar to each other as those shown in Figs. 5 and 6.

Not only do we find animals whose young stages differ more than the adults, but we also meet cases—and they are very numerous indeed—where the order of appearance of organs and features of the greatest taxonomic importance differs in the embryos of closely related forms.

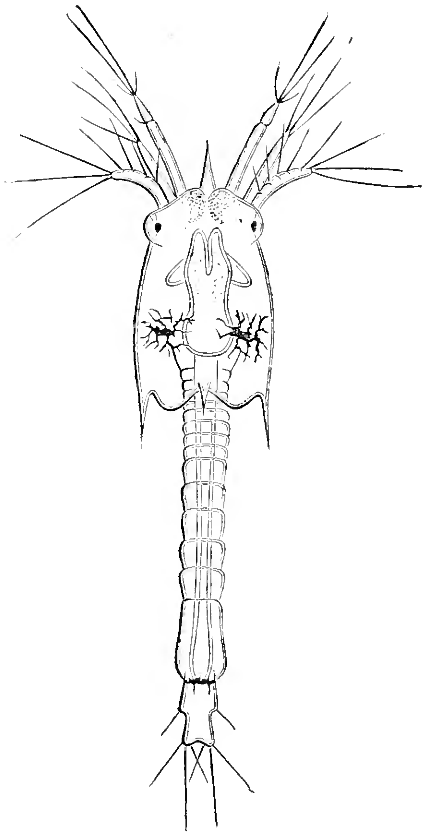


Fig. 8.

To take a particular instance, it is plain that, since the features which all the two-gilled cephalopods have in common, and which are characteristic of the group as a whole, must have been inherited from the common ancestor of the whole group, they ought, unless the embryonic history of the different recent species has undergone secondary modifications, to appear in the same order in the embryos of all the existing forms; and, if they do not, it is clear that descriptive embryology alone can not furnish a key to systematic affinity.

As a matter of fact, each one of the three species of two-gilled cephalopods with whose embryology we are most familiar differs from both the others in the order in which such significant organs as the arms, the shell, the eyes, the siphon, the gills, and the mouth make their appearance; and it must be obvious that, unless we have some means of analyzing these three life-histories, and determining which of them gives the true ancestral order, we can not make use of their embryology as a key to phylogeny. One who is not familiar with the whole field of life-science may fairly ask how it is possible to discover the relationships of animals from the study of their embryology if it is true that the early stages in the life of closely related species may differ so greatly, and if it is true that the order and manner in which structures make their appearance in the embryo are not alike in all cases. Before answering this question, we must call the attention of the unscientific reader to a familiar fact which will throw great light upon the matter.

The animals with which we are most familiar, the mammals and birds, are born in substantially the form which they will have when they reach maturity. They breathe the same medium; they employ the same organs of locomotion, in the same way; they require the same or nearly the same kind of food, and their habits and surroundings are the same as they will be during mature life, or at least the differences are slight and insignificant, and the adult is little more than the young animal grown to its full size, and with sexual characteristics, and able to reproduce its kind. But we must recollect that, in the greater part of the animal kingdom, this is not the case. In by far the greater part of the species of animals the rule is that the newly born young is very different, in structure, in habits, surroundings, and needs, from the adult, and its passage to the adult form is not simply a process of growth, but a process of great change in every particular.

The young butterfly crawls over the plant on which it is born, and finds an abundant supply of proper food in the green leaves, which it cuts to pieces with its strong, scissor-like jaws. Its capacious digestive tract is fitted for dealing with great quantities of bulky but very slightly nutritious food; and its enemies, dangers, and means of defense are very different from those of the adult winged insect, which is furnished with highly developed sense-organs, and flies from place to place in search of the highly concentrated liquid food adapted for sucking up through the proboscis which has replaced the cutting jaws of the young; and we must recollect that the life-history of the butterfly, so far as its great changes are concerned, is a type of the life of numbers of other animals, for nearly all the invertebrates pass through a metamorphosis.

Whenever young animals are left to shift for themselves, without parental protection, they are compelled to struggle for existence with a host of competitors and enemies; and in all cases where the structure and habits of the young differ from those of the adult, a variation in the young animal may be as important for the welfare of the species as one in the adult, and may, therefore, be seized upon and perpetuated by natural selection, and in this way the young stages of two closely related species may be modified in different directions until they become quite different from each other, while the adults may remain essentially alike; and as natural selection may act in such a way as to modify the life-history of an organism at any stage of its existence, there is no limit to the secondary changes which may thus be brought about. A larva may acquire new organs, or it may lose old ones; the order in which organs are acquired may be modified; stages of development may be dropped out of the series, or new ones may be added. A young form may become adapted to a new mode of life, or it may escape competition by seizing upon a new field; its enemies, dangers, and means of defense may change, and with these changes of habits corresponding changes of structure may occur, so that the primitive or ancestral record may become completely obscured by secondary changes.

The examination of the various kinds of modification which may be brought about in this way falls within the scope of a treatise on comparative embryology, but it would be out of place here, although one or two examples of the more common sorts of modification may be of interest.

The chrysalis stage of butterflies is an instance of the secondary acquisition of a new stage of development, which forms no part of the ancestral record.

It is obvious that the inactive pupa, which takes no food, and exhibits few of the ordinary activities of animal life, can not possibly have existed in the past as an adult ancestor of the butterflies, nor is it conceivable that any of the remote ancestry of this group bore a general resemblance to a pupa. While it is impossible to believe that the pupa stage is ancestral, we have good evidence to show the manner in which it has been acquired as a secondary modification.

Lubbock has pointed out that the least specialized or most primitive insects have mouth-parts which are indifferently adapted for either cutting or sucking, and that these insects do not undergo a metamorphosis, but are gradually converted into the adult form by a simple process of gradual development. He also shows good ground for believing that the common ancestors of all the groups of insects were like these forms in these particulars; and he holds that, as the stock which led to our present butterflies was evolved from this ancient stem-form, the young became adapted to a sedentary creeping life, and their indifferent mouth-parts became gradually converted into cutting jaws, while the adults became adapted to quite a different mode of life, and the same indifferent mouth-parts became gradually modified into a sucking proboscis. While the caterpillar and butterfly were thus diverging in two directions from the original unspecialized form, and the structure and habits of the larva were becoming more and more different from those of the adult, it is plain that the metamorphosis must at the same time have become more and more violent; and, according to Lubbock, one of the periods of slight activity which, in most insects, accompany the periodical molts, was seized upon, and gradually extended into a long resting or chrysalis stage, in order to enable the animal to exist while the highly specialized organs of the caterpillar are changing into the equally specialized but very different organs of the winged insect. The growing butterfly now passes through a resting or pupa stage which connects the two periods of great specialization, and bridges over the gap between them, and thus does away with a period of imperfect specialization to both modes of life.

As an instance of the opposite kind of modification, the simplification of an embryonic history by the loss of ancestral stages, we may take the life of the fresh-water crawfish. Young lobsters, and most of the other marine allies of the crawfish, leave the egg in a form which is quite unlike the adult, in structure as well as in habits, and the new-born young pass through a long series of stages of metamorphosis before the mature form is reached.

The larval stages of the marine long-tailed crustacea bear such a resemblance to each other, and to certain lower crustacea, that we must regard them as ancestral; and we must therefore believe that they were one time present in the life-history of the crawfish, although we find nothing of the kind now. These larval forms are adapted to a swimming life at the surface of the ocean, and we can understand that, when the ancestors of the crawfishes became adapted to a life in fresh water, the larval stages must either have been modified to correspond or else been got rid of, and, in the crayfish, the latter has happened, and the new-born young is simply a very small image of the adult, the whole metamorphosis having been suppressed.

A person who is unfamiliar with morphology may fairly ask whether we are not entering upon treacherous ground, and why we are to regard the life-history of the lobster as the ancestral one, and that of the crawfish as a secondary modification, rather than the reverse. This feeling is not confined to unscientific thinkers, for many naturalists are inclined to reject this conception of the falsification of the embryonic record, and to say that, when we accept the evidence furnished by one species as a basis for phylogeny, and reject the evidence of a related species as of no taxonomic importance, we are actuated by mere caprice, or by a desire to establish some pet hypothesis, and that this method of reasoning can have no scientific value.

The most satisfactory answer to this objection would be a thorough analysis of a specific example, but this would involve technical comparisons and discussions which could not be adequately presented without a number of figures; and a sufficient answer for our present purpose may be found by a reference to the facts and conclusions of comparative anatomy.

A whale differs from all the ordinary mammals in quite a number of features in which it bears a close resemblance to fishes, and at the same time it differs from fishes in a number of points of resemblance to mammals. The attention of the earlier naturalists was attracted by the first set of resemblances and differences, and they placed the whale among the fishes; but later investigators have decided that the second set of resemblances alone give any evidence of systematic relationship, and that the whale is a mammal. Now, what reason is there for regarding one set of resemblances as of taxonomic importance rather than the other? The answer is plain. It is easy to show that all the features in which a whale resembles fishes are such as we should expect to find if the whale is a mammal, adapted to an aquatic life; but the features of resemblance to an ordinary mammal do not admit of any such explanation, and they must therefore be held to indicate the true relationship.

If the crawfish originally passed through stages somewhat similar to those of the growing lobster, we can see why they may have been suppressed to adapt it to a life in fresh water; but, if the life-history of the crawfish is ancestral, we can find no reason, in the life of the lobster, for the acquisition of larval stages which are like these of more distantly related macroura, and, in rejecting one life-history and accepting the other, we are simply carrying the accepted principles of homological reasoning into wider fields, and applying them to a new class of phenomena; and a thorough acquaintance with the facts will render our conclusions as thoroughly scientific in the one case as in the other.

Those who are unfamiliar with the status of modern morphology are still accustomed to regard systematic zoölogy as a science of observation, but our review of the subject shows that the attempt to trace out the natural system of classification of animals carries us far beyond the bare facts, and that the observed phenomena, although practically infinite in numbers, bear about the same relation to the generalizations of the science that the facts of mathematics or of astronomy do to the general laws of these sciences.

The facts are so numerous and so difficult to observe, and our acquaintance with the conditions of life is so slight, that our attempts at general conclusions must frequently be tentative and provisional, and in some cases future research may show that they are entirely wrong; but this is no valid objection to the use of such evidence as we have. There is no more justice in the assumption that, because they may possibly be wrong, phylogenetic speculations upon the basis of paleontology, comparative anatomy, and embryology are adverse to the best interests of science, than there would be in the assumption that the attempt to trace the relationship of animals from the facts of homology is unscientific, because Cuvier thought that he had discovered homologies between the barnacles and mollusks, or because Agassiz associated the vorticellas with the polyzoa.

The end of phylogenetic speculation is perfectly legitimate, but we must rid our minds of the belief that it can be reached by mere observation and description. The evidence is often so hard to read that the accounts of the best observers are contradictory, and in many cases it is so scanty and incomplete that it must be submitted to a severely critical process of comparison, analysis, cross-examination, and elimination, before a general conclusion can be reached. The field is so vast, the amount of evidence so great, and special features are so numerous, that the thorough discussion of the problem in all its bearings will furnish employment for the most acute and comprehensive powers of analysis for an indefinite period; but there is no reason to believe that the subject is beyond our grasp, or that it is not a perfectly proper field for intellectual activity.

We may fairly ask, though, whether, after all this is granted, it pays to spend our time in speculation upon circumstantial evidence, when all our conclusions may possibly be wrong, when they can not possibly be true unless they are put into a general form, and when the presumption in their favor is only a probability at best. Would it not be wise for us to spend all our time in the observation of nature, rather than to devote our energies to the discussion of general problems?

In matters where we are called upon to act we must weigh the probabilities, and form the best judgment we can according to our evidence; but this is necessary because we must act in any case, and it is no reason for carrying scientific thought into similar fields. In life it is often wise to act against the probabilities, as when an old man denies himself to make provision for a prolonged life, which he has very little chance of enjoying; but it does not follow that it is wise to form a scientific conclusion against the probabilities, and, if the analogy of actual life will not justify this, how can it justify a scientific conclusion which is based upon probabilities in the absence of demonstrative evidence?

If science were a pure abstraction, standing by itself, this objection might have weight; but no part of the phenomenal world does stand by itself, and nothing in nature is so independent of human interests that broader knowledge does not conduce to wiser judgments and actions: nor is the past history of life a remote subject, bearing so slightly upon human interests that it may properly be left to occupy the time and energy of future generations.

It has the same importance to us as living things that the history of the human race has to us as human beings. The future history of our race will be a continuation of the one line as well as of the other, or, rather, one is included by the other. The end of the study of history is not the discovery of what has been in the past, but the discovery of general laws and causes that shall enable us to foresee what is to take place in the future; but this sort of historical knowledge, the wisdom of history, does not come from observation, but from reflection upon the inner relations, the causes and effects of phenomena—from a weighing of the probabilities between one interpretation and another; and the wisdom which leads us to accept and act upon these probable conclusions, as the best available basis for the guidance of conduct, equally requires us to accept, in the same way, the results of the study of our prehistoric life-history. Our conclusions may be wrong, but, so long as they are the best, we can not regard them as abstractions. We must welcome them as something more than knowledge—as an increase of wisdom in its widest sense.

If this justification of morphological speculation seems vague and indefinite, we need not seek far for more concrete reasons for encouraging this kind of thought, one of the most important features of which is its value as an intellectual discipline.

We can hardly overestimate the value of the power to reach logical conclusions, for this power is the basis of all wise conduct, and that education which aids in its acquisition has pre-eminent claims upon our attention. In almost every case where we are called upon to form a judgment, and to act upon it, the premises are so uncertain, the conditions of the problem so numerous and so little known, and its relations to other things admit of so much variation, that our conclusion can be nothing but a probability; and it is of the greatest importance that the mind should be trained in such a way as to fit it for forming wise judgments upon this class of complicated and indefinite problems.

Now, the questions which are presented for solution in the more exact physical sciences differ from the questions of morphology in the same way that they differ from the problems upon which we are constantly called to decide and act in ordinary life, but the degree of difference is less.

While the number of factors involved in a morphological problem is vastly greater than that of those which bear upon any problem into which life does not enter, and while the relations between these factors vary, in closely allied cases, in a way which has no parallel outside life-science, the problems of general morphology are still vastly simpler than those of society or of morality, or of almost any other department of human conduct, although they are like them in kind, and supply the same sort of evidence. The attempt to trace the mode of action of a constantly changing environment upon a form of life inheriting from an unknown series of ancestors a constitution that has been modified by a series of changes that can not be repeated, is no bad training for the attempt to foresee the working of a social reform that admits of no experiment, but must be tried once for all; which involves so many side-issues that no exact parallel to it can be found, and which is so complicated that it is impossible to foresee or follow out its results in detail.

The problems of the physical sciences are too definite and simple to afford much intellectual training in this most important field, and the problems of human life and society are too involved, too diversified, and too changeable to afford a proper field for studying the logical basis of our opinions; but in morphology we find what is needed, a field midway between the two.

The discipline which is to be obtained by the careful mastery of such a work as Claus's speculation upon the origin of the crustacea, or by the critical study of the problem of the vertebrate skull, or by the study of the literature upon the affinity between the vertebrates and the annelids, is a better training in that logic of probabilities which is the basis of all conduct than can be found in the study of the other sciences; and from this point of view it is plain that good may result from honest but erroneous attempts at morphological speculation, for the logical restrictions of sound reasoning are often studied to the best advantage in the errors of acute thinkers.

PLAYAS AND PLAYA-LAKES.

By ISRAEL C. RUSSELL.

OF the many characteristic features of the arid region of the far West known as the Great Basin, none attract the attention of the traveler more forcibly than the desert mud-plains that have been left by the evaporation of former lakes.

These areas are known locally as mud-flats, salt-flats, salt-marshes, borax-flats, alkali-flats, deserts, sinks, etc., the name usually indicating some peculiar feature of the valley to which it is applied. As these desert regions have an almost identical history, the Spanish word *playa* —meaning *shore* or *strand*—has been adopted by geologists as a generic term under which the various desiccated lake-basins may be grouped. Valleys more absolutely desolate than the playas of the Great Basin can not be found, even in the midst of Sahara. They occur as mud-plains, occupying the lowest portion of arid valleys, and form a horizontal, even floor that is soft and perhaps covered by a shallow lake during the winter, but in the summer and fall becomes hard and dry, and crossed by innumerable shrinkage-cracks that give the whole broad surface the appearance of a tessellated pavement of cream-colored marble. At other times, after the water has evaporated, the salts contained in the mud of the playa are brought to the surface in solution by the action of capillary attraction, and a saline incrustation is formed on the surface of the desert when the water that held the salts in solution evaporates. In such instances the playa appears as white and dazzling as if covered with drifting snow. A journey across such a plain during the heat of summer, when the mirage renders even the most familiar land-marks uncertain, becomes the most weary and trying that the explorer is called upon to make.

Examples of playas of broad extent are furnished by the desert region that borders Great Salt Lake on the west, which was left as a vast mud-plain by the evaporation of Lake Bonneville. This is an absolute desert, more than a hundred miles long by thirty or forty miles broad, composed principally of fine, tenacious, greenish clay. Other areas that now exist as great playas occur on the Carson Desert and on the Black Rock and Smoke Creek Deserts of Northwestern Nevada: these are portions of the bottom of Lake Lahontan that have been laid bare by the desiccation of the former lake. Playas of smaller extent, but which are yet typical examples of the deserts left by the withdrawal or evaporation of Quaternary lakes, are found in Diamond Valley, White-Pine Valley, Gabb's Valley, and Osobb Valley. All of these examples are in Nevada; but hundreds of others, of greater or less extent, might be enumerated that are scattered throughout the length and breadth of the Great Basin. As already mentioned, many of these playas are covered with water during the rainy season. Others exist as lakes, excepting when the season is unusually dry. They then become mud-flats that can not be distinguished from the playas that become dry and hard every summer.

The lakes that cover playas at certain times, and appear and disappear as the wet and dry seasons alternate, and are sometimes born of a single shower, and become many square miles in area during a single night, may with convenience be designated as *playa-lakes*, as they have many features peculiar to themselves. These lakes are without outlets, are seldom more than a few feet deep, and usually hold no more than a few inches of water; they are commonly alkaline or brackish, and are always, so far as the observations of the writer extend, of a peculiar yellowish or greenish-yellow color. The characteristic tint is due to the extremely fine mud, and probably chemical precipitates, that the waters hold in suspension. Owing to the extreme shallowness of these lakes, the fine mud at the bottom is agitated by every breeze, and thus the clearing of the water by the subsidence of the material held in suspension is prevented.

Playa-lakes, that form in the wet season and vanish again during the summer months, occur in a great number of the desert valleys and small inclosed basins to be found in the arid region between the Sierra Nevadas and the Wahsatch range. Some of these annual lakes are of considerable dimensions. On the northern part of the Black Rock Desert, Nevada, where Quin's River enters the desert from the northeast, a shallow lake is formed during the rainy season that is reported to be from ten to fifteen miles broad and as much as forty or fifty miles in length. When the dry season comes on, this lake evaporates, and the river that formed it shrinks back seventy-five or a hundred miles, leaving its channel a dry water-course, with perhaps a few water-holes to indicate its former extent.

Examples of playa-lakes that reach desiccation only during exceptionally dry seasons are furnished by Eagle Lake, Worth Carson Lake ("Carson and Humboldt Sink"), and Yellow-water Lake, in Nevada, and by Honey Lake and the lakes of Surprise Valley in California.

We have spoken of playas as being formed by the annual evaporation of small lakes ; others by the evaporation of lakes after a term of years when the season was unusually dry ; there are also other playas that are only covered with water during exceptionally wet seasons. One might perhaps include in the list of playa-lakes the great lakes of the Quaternary, whose fluctuations extended through geological periods, and whose desiccation has left the largest of all the playas. Lake Bonneville and Lake Lahontan, however, can be called playa-lakes only during the closing chapters of their history ; in the earlier portions of their existence, they were fresh-water lakes of great depth, and one of them, at least, overflowed.

When we examine the material composing playas more critically, we find that they are formed of at least two varieties of sediments. In the broad, open playas, like Great Salt Lake Desert and the two desert regions of the Lahontan Basin in Nevada, the surface is composed of soft, fine, greenish, saline clay, that is commonly saturated with alkaline water at a depth of a few feet, and becomes tenacious and difficult to handle. These clays are, without question, simply lake-beds that were deposited by sedimentation at the bottom of the great lakes that once occupied the valleys where they are found.

The second variety of playa-beds occurs in restricted basins and in valleys that are without outlets. These are found very commonly behind shore-bars of Lake Bonneville and Lake Lahontan, and in valleys and cañons the mouths of which have been crossed by the embankments of gravel built along the shores of these Quaternary lakes. The material forming playas of this nature is always of a light yellowish color, becoming almost white when dry ; is extremely fine, and readily crumbles into dust between the fingers ; near the surface, the beds are full of small globular vesicles that were apparently once filled with gas or water. These characteristics hold good even when the playas are surrounded on all sides by dark basalts, from the disintegration of which the playa-beds must have been formed.

True playa-beds, composed of light-colored material as described above, have been penetrated to the depth of five to six feet without revealing any change in the composition of the deposit. The thickness that may be reached by these slowly accumulating beds depends on the nature of the basin in which they are deposited ; in some cases they can not be less than twenty or thirty feet in thickness. The coarse material swept down the sides of these inclosed basins by the infrequent rains is invariably left at the edge of the playa, and in a section of the beds appears as thin wedges of gravel and angular fragments, that thin out and become lost as we trace them away from the shore. Playa-beds may become covered with lake-beds, thus forming a peculiar light-colored stratum, in reality a fossil playa, that bears record of a time of desiccation ; and, when lake-beds occur below, it is evidence that a dry period has intervened between two periods of more abundant precipitation.

The salts that form on the surfaces of playas are composed principally of the chloride, sulphate, and carbonate of soda, but sometimes contain borate of soda, sulphate of potash, sulphate of magnesia, and other salts in smaller proportion. In places the surface of a playa is sometimes formed of sulphate of soda several feet in thickness, as near the Buffalo Salt-Works on the Smoke Creek Desert, Nevada. Again, crystals of sulphate of lime (selenite), forming a bed more than six feet thick, cover hundreds of acres of the playa-surface, as on the eastern border of the Sevier Desert in Utah. Sometimes a playa for many square miles in extent is covered by a layer of salt a few inches in thickness, as was the case when Sevier Lake in Utah evaporated to dryness a few years since, and as is shown also by the large salt-field in Osobb Valley, Nevada. At other times the beds composing the playa contain brine beneath the surface, which yields large quantities of nearly pure salt upon evaporation; the supply of salt from this source in Nevada is practically without limit.

When by a change of climate a playa is no longer flooded, the subaërial gravels that are constantly moving down toward the bottom of a valley eventually overflow the entire surface of the playa, and the valley acquires a rounded instead of a horizontal floor. The same action tends to obliterate the beach-marks that a lake makes along its shores, so that in time all records that a lake has once occupied a valley become buried and erased: where once a broad, clear lake existed in which glacial covered peaks were reflected, there now stretches an arid desert, bearing only a scanty growth of artemisia. This, in brief, is the history of a large number of the valleys of the Great Basin.

SCIENTIFIC FARMING AT ROTHAMSTED.

By MANLY MILES, M. D.

II.

THE primary and leading object of the experiments with animals, which have been conducted at Rothamsted during the past thirty-five years, was the solution of practical agricultural problems; but, as in the case of the field experiments already noticed, the practical lines of inquiry have naturally led to the investigation of a wide range of topics belonging to the science of biology, which, in themselves, are of more particular interest to the physiologist, or even to the student of sanitary or of social science, than to the farmer.

From the number of animals under experiment, and the well-planned and thorough methods of investigation, in all departments of the experimental work, the results obtained have been of great value, not only from the light thrown on many of the obscure processes of nutrition, but also in laying a foundation for a consistent system of feeding, in which the relations of the food consumed to the special animal products obtained, and to the value of the manure produced, as an incident of the process, are clearly traced.

In determining the amount of food and of its several constituents consumed for a given live weight of the animal in a given time, and the amount of food and of its several constituents required to produce a given amount of increase in live weight, several hundred animals, including oxen, sheep, and pigs, were subjected to experiment. In these researches, selected lots of animals were supplied, for weeks or months, with weighed quantities of food of known composition, as determined by analysis, and especially adapted to the particular point under investigation. The animals were weighed at the beginning, at intervals during the progress, and at the close of the experiment.

The composition of the manure produced from a given amount and quality of food consumed, by oxen, sheep, and pigs, was determined in a large number of cases by analyzing average samples of the food, and then making an analysis of the solid and liquid excretions of the animals. In these experiments, the oxen were fed in boxes in which the manure was preserved with litter of known composition. After feeding for from five to nine weeks, the total manure produced was carefully mixed, weighed, sampled, and analyzed. By this method the solid and the liquid excreta were not separately examined. With sheep no litter was used, the animals, in lots of five, being fed on a slatted platform with an inclined floor of sheet-zinc below it, so that the urine was drained into carboys containing acid, while the solid excretions were separately removed several times a day and preserved for analysis. The constituents determined in the food and in the manure in the experiments with oxen and sheep were dry matter, mineral constituents, and nitrogen, and in some cases woody fiber. As an illustration of some of the difficulties that must be overcome in making exact investigations of this kind, a more particular description of some of the devices resorted to will be of interest. "In the case of pigs, individual male animals were experimented upon, each for periods of three, five, or ten days only. Each animal was kept in a frame, which prevented it from turning around, and having a zinc bottom, with an outlet for the liquid to run into a bottle, and it was watched night and day, and the voidings carefully collected as soon as passed, which could easily be done, as the animal never passed either fæces or urine without getting up, and in getting up he rang a bell and so attracted the notice of the attendant. The constituents determined were, in the food and fæces, dry matter, ash, and nitrogen, and in the urine, dry matter, ash, nitrogen, and urea."

The amount and relative proportion of the different organs and parts of the body were determined in two hundred and forty-nine sheep, fifty-nine pigs, two calves, two heifers, and fourteen bullocks. As the object of this investigation was to obtain average data as to the proportions of the valuable carcass parts and the less valuable offal parts, in animals in different conditions as to fatness, a variety of animals were examined. The sheep under experiment may be grouped as follows: five sheep of different breeds in the lean or store condition; one hundred sheep of different breeds moderately fattened; forty-five sheep of different breeds excessively fattened; seventy-eight Hants Down sheep moderately fattened on different foods; and twenty-one sheep of different breeds and modes of feeding of more than average fatness. The fifty-nine pigs were moderately fattened on a variety of fattening foods.

The percentage weights of the different parts of the body of the three classes of animals, and of the sheep in the store, the fat, and the very fat condition, are given in the following condensed table from Dr. Lawes's lecture before the Royal Dublin Society:

PARTS OF THE BODY.	Average of 16 oxen.	Average of 249 sheep.	Average of 59 pigs.	Average of 5 store sheep.	Average of 100 fat sheep.	Average of 45 very fat sheep.
Stomachs and contents	11·6	7·5	1·3	9·1	7·0	5·6
Intestines and contents	2·7	3·6	6·2	5·3	3·8	2·8
	14·3	11.1	7·5	14·4	10·8	8·4
Internal loose fat	4·6	6·9	1·6	4·5	6·0	7·5
Heart, aorta, lungs, windpipe, liver and gall-bladder, with contents, spleen, pancreas, and blood	7·0	7·3	6·6	8·4	7·7	6·5
Other offal parts	13·0	15·0	1·0	17·9	16·1	13·1
Total offal parts	38·9	40·3	16·7	45·2	40·6	35·5
Carcass	59·3	59·2	82·6	53.4	58·7	64·1
Loss by evaporation, etc	1·8	0·5	0·7	1·4	0·7	0·4
Total	100·0	100·0	100·0	100·0	100·0	100 0

It will be seen that the stomach and contents make up 11·6 per cent of the live weight of the oxen, 7·5 per cent of the live weight of the sheep, and but 1·3 per cent of the live weight of the pigs, while the intestines and contents rank in the inverse order, giving the highest percentage in pigs and the least with the oxen. If the stomachs and intestines are taken together, we find the highest percentage in the oxen and the least percentage in the pigs. These figures correspond very closely to the relative amount of work required in the digestion of the food of the different animals, which is coarse and more bulky in the case of the oxen, and comparatively concentrated and of higher nutritive value in the case of the pigs. The greater relative development of the intestines in pigs has a probable relation to the more complete assimilation of the food of these animals. As a whole, the glandular and circulatory organs, which are grouped together in the table, are nearly in the same proportion in the three groups of animals, the range of variation being but little more than one half of one per cent. It should be stated that the much smaller percentage of offal parts, and the corresponding larger percentage of carcass, in the pigs, is partly to be attributed to the head and legs being included with the carcass of the pigs, while they are reckoned as offal parts in oxen and sheep. With sheep there was a rapid decrease in the percentage of offal parts as the animals fattened, while the percentage of carcass increased from 53·4 in the store condition to 64·1 in the very fat condition. There was, however, an actual increase in the offal parts from the store to the very fat condition in the proportion of one to one and three quarters, but the carcass parts made a greater actual increase, one pound in the store condition being raised to two and one half pounds in the very fat condition.

In connection with the data furnished by the mass of facts relating to the relative proportion of organs and parts of the body, which we can not discuss in detail, it became a matter of interest to ascertain the chemical composition of the increase of fattening animals obtained from different articles of food, so that the relations of the food constituents to the constituents of the increase could be determined. As a chemical analysis of a living animal can not be made, it is of course impossible to determine directly the chemical composition of the increase, as an analysis would be required at the beginning and at the close of the fattening period. The composition of the increase of fattening animals must therefore be determined by indirect methods, as by calculation from the data furnished by the differences in the composition of the food and the excretions; or from assumed constants, in the form of averages obtained by analyzing a large number of representative animals.

The most satisfactory data relating to this subject, that have ever been published, will be found in the results of the numerous analyses of the entire bodies and parts of animals, in different conditions as to fatness, that have been conducted at Rothamsted. Determinations were made of the fat, nitrogenous substance, and mineral matter of the entire body, and of certain separated parts, of ten animals, described as follows: 1. A fat calf, of the shorthorn breed, nine or ten weeks old, taken from its dam, feeding on grass; 2. A half-fat Aberdeenshire ox, about four years old, fed on fattening food, but which had grown rather than fattened; 3. A moderately fat Aberdeenshire ox, about four years old; 4. A fat Hampshire Down lamb, about six months old; 5. A Hampshire Down store sheep, about one year old; 6. A half-fat Hampshire Down ewe, three and one fourth years old; 7. A fat Hampshire Down sheep, one and a fourth year old; 8. A very fat Hampshire Down sheep, one and three fourths year old; 9. A store pig; 10. A fat pig. The pigs were of the same litter, and, when selected, were as nearly as possible alike, one weighing one hundred pounds and the other one hundred and three pounds. "One was slaughtered at once, and its contents of nitrogenous substance, fat, mineral matter, etc., accurately determined. The other was fed on a mixture consisting of bean-meal, lentil-meal, and bran, each one part, and barley-meal three parts, given *ad libitum*, but accurately weighed, for a period of ten weeks, when it had nearly doubled its weight. The animal was then slaughtered, and analyzed as the other had been. The composition of the food was also determined by analysis."

According to the generally accepted theory of nutrition at the time the Rothamsted feeding experiments were planned, the constituents of foods were divided into two leading groups, each of which was assumed to serve a special purpose in the system. It was believed that the nitrogenous constituents were the only nutritive elements, and that the carbonaceous constituents (including the fat, starch, etc.) served as fuel, which was burned in the system to keep up the animal heat. In the published analyses of animals and of foods at Rothamsted, this distinction was recognized, and the results are given in terms of these groups of constituents. A summary of the results of the analyses of the ten animals described above is given in the following table, in percentage values of groups of constituents, in the carcass and in the total offal parts:

ANIMALS.	Mineral matter (ash).		Nitrogenous substance (dry).		Fat (dry).		Total dry substance.		Water.	
	In carcass.	In offal.	In carcass.	In offal.	In carcass.	In offal.	In carcass.	In offal.	In carcass	In offal.
Fat calf	4·48	3·41	16·6	17·1	16·6	14·6	37·7	35·1	62·3	64·9
Half-fat ox	5·56	4·05	17·8	20·6	22·6	15·7	46·0	40·4	54·0	59·6
Fat ox	4·56	3·40	15·0	17·5	34·8	26·3	54·4	47·2	45·6	52·8
Fat lamb	3·63	2·45	10·9	18·9	36·9	20·1	51·4	41·5	48·6	58·5
Store sheep	4·36	2·19	14·5	18·0	23·8	16·1	42·7	36·3	57·3	63·7
Half-fat old sheep	4·13	2·72	14·9	17·7	31·3	18·5	50·3	38·9	49·7	61·1
Fat sheep	3·15	2·32	11·5	16·1	45·4	26·4	60·3	44·8	39·7	55·2
Extra-fat sheep	2·77	3·64	9·1	16·8	55·1	34·5	67·0	54·9	33·0	45·1
Store pig	2·57	3·07	14·0	14·0	28·1	15·0	44·7	32·1	55·3	67·9
Fat pig	1·40	2·97	10·5	14·8	49·5	22·8	61·4	40·6	38·6	59·4
Means of all	3·69	3·02	13·5	17·2	34·4	21·0	51·6	41·2	48·4	58·8

This table furnishes some important data for an intelligible discussion of the economics of nutrition, with reference to human dietaries, but there are many points of interest presented in the details of the analyses of these animals that can not be embraced in such a tabular abstract. In the carcass of the fat calf, it will be noticed, the percentage of nitrogenous substance and of fat is the same, while in the other animals the fat is largely in excess, even in those in store condition. There is likewise a larger percentage of nitrogenous substance in the offal parts than in the carcass in all cases. It was also found that "the fat of the bones bears but a small proportion to that of the whole carcass, while, of the whole of the nitrogen of the carcasses, perhaps not less than one fifth will be in the bones. . . . As the animal matures, the mineral, the nitrogenous, and the fatty matters all increase in actual amount; but the percentage of both mineral matter and nitrogenous substance decreases, while that of the fat increases so as to much more than compensate for the decrease in that of the other solid matters. The result is that there is an increase in the percentage of total dry substance." The young animals, as the lamb and calf, had a larger proportion of water in the carcass than other animals in the same condition; and there was a larger proportion of bones in the carcass of the calf than in the carcass of the other animals.

In estimating the composition of the increase in live weight of fattening animals it was assumed that the composition of the original weight, that is, the weight at the beginning of the feeding period, was the same as in the "store" or "half-fat" animals that had been analyzed; and that the composition of the animal at the close of the feeding period was the same as that of the "fat" or the "very fat" animal that had been analyzed. By a proper exercise of judgment as to the comparative condition and quality of the animals at the beginning and end of the feeding period, and applying the data derived from the analysis of animals of similar quality, a close approximation to the composition of the increase could thus be obtained, and the probable error would be reduced to a minimum when the averages were made up from a large number of animals. In this way the composition of the increase was estimated in the case of ninety-eight fattening oxen, three hundred and forty-nine fattening sheep, and eighty fattening pigs, divided into numerous classes according to breed, condition of maturity, and description of food consumed. The estimated average percentage of mineral matters, nitrogenous substance, fat, and total dry substance, in the increase of these animals, is given in the following table:

ANIMALS.	Mineral matter (ash).	Dry nitrogenous substance.	Fat.	Total dry substance.
98 oxen—average	1·47	7·69	66·2	75·4
349 sheep "	2·34	7·13	70·4	79·9
80 pigs "	0·06	6·44	71·5	78·0
The analyzed fat pig	0·53	7·76	63·1	71·4
Means	1·10	7·25	67·8	76·2

The averages of all the animals under experiment, fed under a variety of conditions, and including the "fat" and the "very fat," are here given. In the tables which follow, however, data from selected cases are made use of, which do not change the general results, but represent, it is believed, more nearly, the results obtained in ordinary farm practice.

The percentage of mineral constituents in the increase of the sheep as given in the table is undoubtedly too high, from the presence of foreign matters in the wool which could not well be separated; this will of course affect the percentage of total dry substance which is the sum of the figures given in the three preceding columns.

We may now consider the relations of the constituents of the food to the constituents stored up in the increase. In the experiments to determine the amount of food and of its several constituents, consumed by an animal of given weight within a given time, and required to produce a given increase in live weight, the foods presented a wide range of variation in composition, and the rations were so planned that the animals had a supply of *ad libitum* food containing more or less nitrogenous substance, that enabled them practically to fix for themselves the relative proportions of the nitrogenous and non-nitrogenous constituents consumed. In all of the feeding experiments it was found that the amount of food consumed by a given live weight of the animal, within a given ti ne, and also the increase in live weight obtained from it, depended more upon the non-nitrogenous constituents, or even on the total dry substance, than upon the nitrogenous constituents, which had been generally assumed to be the true measure of nutritive value. In experiments with animals expending their energies in the form of work, the same demand for the non-nitrogenous constituents of the food was observed as in the case of fattening animals. A certain moderate amount of nitrogenous substances was evidently needed in the food, but any increase beyond this required quantity had no influence upon the returns obtained for food consumed, either in the form of muscular force in working animals, or in increase in live weight in those that were fattened, or even on the amount of nitrogen contained in such increase. The nitrogen discharged in the urine, in the form of urea, was found to have no relation to the activity of the muscles, but it was directly increased by an increment of nitrogenous materials in the food. The age and habits of the animals themselves, when growing or fattening, seemed, however, to determine, to some extent, the proportions of nitrogenous materials in the stored-up increase.

The average results show that oxen supplied liberally with food of good quality, containing a moderate proportion of grain or other concentrated food, would consume at the rate of from twelve to thirteen pounds of dry substance* per week for each hundred pounds of their weight, and that one pound of increase in live weight would be returned for it. Sheep, of several different breeds, consumed, on the average, about fifteen or sixteen pounds of dry substance of slightly better food per week for each hundred pounds of live weight, and returned about one pound of increase in weight for each nine pounds of dry substance in their food. Pigs, with food composed largely of

* Cattle-foods differ widely in the amount of contained water; the average being in hay from ten to fifteen per cent, in grain from eight to fifteen per cent, and in roots from seventy-five to ninety per cent. The strictly "dry substance," excluding this variable element of water contents, is therefore taken as a basis in estimating nutritive values.

grain, consumed from twenty-six to thirty pounds of dry substance per week, for each hundred pounds of live weight, and yielded one pound of increase in weight for each four or five pounds of dry substance in their food. Oxen, therefore, consume more dry substance of food, in proportion to their weight, than sheep, and sheep consume more than pigs, while, in return for feed consumed, pigs yield more than sheep, and sheep gave better results than oxen. It must be remembered in this connection, as has already been pointed out, that the food of oxen contained more woody fiber, while that of the pigs was comparatively concentrated and digestible, and therefore of better quality. With sheep of different breeds it was found that, under the same conditions as to age and fatness, the food consumed was in proportion to their live weight. The relative value of the larger and smaller breeds seems, therefore, to depend, to a great extent at least, upon their habits and hardiness, and their adaptation to the conditions of the locality in which they are placed.

In studying these experiments, it will be well to keep in mind the twofold function of food in the animal economy: first, as the source of energy for the performance of work in the various organs of the body, which is required in elaborating the peculiar animal products sought in the process of feeding (as milk, flesh, wool, etc.), and in carrying on the processes of repair and reconstruction to maintain the integrity of the animal machinery; and, in the second place, as supplying the materials for the construction or elaboration of the special animal products. The popular notions of nutrition assume that this supply of materials in the food for the new product sought is the most important, and the supply of energy for the performance of work is overlooked or assigned a subordinate position.

The results of the experiments relating to the use and ultimate disposition of the food consumed by animals when fattened under average conditions, as to feed and increase, are given in the following table:

ANIMALS.	Each 100 pounds of dry substance in the food consumed was disposed of as follows:		
	Stored up as increase.	In manure.	Used in internal work of the system, and not accounted for in manure or increase.
Oxen	6·2	36·5	57·3
Sheep	8·0	31·9	60·1
Pigs	17·6	16·7	65·7

The figures in the last column of the table are not intended to represent all of the internal work of the system. They simply show the amount of non-nitrogenous constituents that are not accounted for in the stored-up increase, or in the manure, and thus are properly designated as having been used in internal work. From an agricultural stand-point, the proportions of food-constituents stored up as increase, and voided as manure, are of the first importance, as these are the two factors that determine the economy of feeding. The expenditure of energy in the system, from the nitrogenous constituents of the food, is not, therefore, included in the last column, as all of the nitrogen of the food that is not stored up as increase is finally excreted in the urine. The first and second columns of the table, therefore, include the nitrogenous and the mineral substances of the food, and any energy that may have been expended as a result of their metamorphoses is not represented in the table.

From the data presented, it appears that more than one half (57·3 per cent) of the food of oxen when fattening is required in internal work, or in keeping the animal machinery in repair, to say nothing of the energy expended by the nitrogenous constituents, while but 6·2 per cent is stored up as increase in weight, and more than one third is found in the manure. With sheep, 8·0 per cent of the food is stored up as increase, less than one third appears in the manure, and 60·1 per cent is used in work of the system. The pigs give 17·6 per cent of the food in increase, or more than twice as much as the sheep, while nearly two thirds is required for internal work, and the manure contains less than one half as much as in the case of the oxen. The pigs store up a much larger proportion of their food as increase than either the sheep or the oxen, but a larger percentage is used in internal work, and less appears in the manure. The increased expenditure in work would naturally follow from the larger amount stored up as increase, which involves as a matter of course an expenditure of energy in its elaboration. But this is not the whole truth, as will be seen on making a comparison of the figures in the first and last columns of the table. For a given amount of increase stored up, the oxen actually expend more in internal work than sheep, and the sheep expend more than the pigs It evidently costs more, in internal work of the system, to elaborate the stored-up increase from the crude feed of the oxen than from the more nutritive food of the pigs. When the facts are examined from a different stand-point, the relations of the increase to work of the system will be more clearly seen, as in the following table, which gives the results obtained from a given live weight of the animals in a given time :

ANIMALS.	For each 100 pounds of live weight, per week.				
		Dry substance.			
	Stored as increase.	Consumed in food.	Recovered in manure.	Used in internal work of the system, and not accounted for in manure and increase.	Used in internal work for each one pound of stored increase.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Oxen.........	1·13	12·5	4·56	7·16	6·34
Sheep........	1·76	16·0	5.10	9·62	5·47
Pigs	6·43	27·0	4·51	17·74	2·76

The oxen make in increase but little more than one per cent of their weight per week, the sheep make one and three fourths per cent, and the pigs nearly six and one half per cent of their weight per week. Nearly the same amount of dry substance of the food appears in the manure of the different animals per week for each hundred pounds of their live weight. In proportion to their weight, the pigs consume more food, and a larger amount of food-constituents is actually used in work of the system, but, from the greater rate of increase, the work required to produce a pound of increase is less than one half of that required in oxen. These facts are of particular interest in connection with the differences already noticed (page 384), in the relative percentage weights of the digestive organs of oxen, sheep, and pigs.

The dry substance of the food has alone been taken into the account in the preceding table, but, if we trace the final disposition of its several constituents in the system, we shall find marked differences in the proportions of each that are stored up as increase, voided in manure, or used in work of the system. The percentage of each group of food-constituents stored up as increase and voided in the manure is given in the next table:

CONSTITUENTS OF FOOD	Each 100 pounds of food-constituents consumed was disposed of as follows:					
	Stored up in increase.			Voided in manure.		
	Oxen.	Sheep.	Pigs.	Oxen.	Sheep.	Pigs.
Nitrogenous substance........	4·1	4·2	13·5	95·9	95·8	86·5
Non-nitrogenous substance....	7·2	9·4	18·5	14·1	8·9	4·1
Mineral matters.............	1·9	3·1	7·3	98·0	97·0	92·7

The nitrogenous substance and mineral matters, as will be seen, are all accounted for in the stored-up increase and the manure, but there remains from 77·4 to 81·7 per cent of the non-nitrogenous substances that can not be found in the increase of the body or in the residual manurial excretions, as they have been used in internal work and excreted in the process of respiration.

Sheep store up as increase a larger proportion of all the food-constituents than oxen, and pigs store up a much larger proportion than sheep. The percentage of nitrogenous constituents stored up as increase or voided as manure will vary widely with different foods. We have seen, as a result of these experiments, that but a small proportion of nitrogenous substance was required in the food, and that the needed amount was comparatively constant under varying conditions. If the food contains but a moderate amount of nitrogenous substance, a larger percentage of it will be required by the system, and the amount appearing in the manure will be so much diminished; but with highly nitrogenous foods a small percentage of the nitrogenous constituents will suffice for the purposes of the system, and the excess will appear in the manure.

Among the many important results obtained in the experiments at Rothamsted, the data furnished for estimating the relative value of barn-yard manures are of particular interest. The essential constituents of barn-yard manure, or those having a commercial value, are nitrogen, potash, and phosphoric acid, which are of course derived from the feed consumed by the animals making the manure. The composition of the food being known, the percentage of its several constituents that are voided in the manure may be estimated from the data obtained in these experiments, so that the relative value of the manure produced from different articles of food can be determined with sufficient accuracy for all practical purposes. From the results of the Rothamsted feeding experiments, we can not avoid the conclusion that the cereal grains and the highly nitrogenous linseed and cotton-seed cakes have essentially the same value as fattening foods, and that there is but little, if any, difference in the feeding value of timothy and clover hay. When the production of manure is concerned, however, the clover has a much higher value than timothy, and the linseed and cotton-seed cakes are worth very much more than the cereal grains. That is to say, the digestible and available non-nitrogenous constituents of the food determine its nutritive value, provided always the moderate required supply of nitrogenous materials is present, and the comparative manurial value is determined by the nitrogenous constituents. A variety in the ration would undoubtedly be desirable for nutritive purposes, as the best results can not be obtained with any single article of diet.

From the facts already presented it appears that a large proportion of the increase of fattening animals, in many cases more than two thirds, is fat. It was formerly supposed that the fat of animals was derived from the fatty materials in the food, but this source was found to be entirely inadequate. The non-nitrogenous constituents of the food—the carbo-hydrates—were then quite naturally looked upon as the source from which the fat was elaborated ; but afterward Professors Voit and Pettenkofer insisted that the fat of animals was almost exclusively formed from the nitrogenous constituents of the food. In experiments with pigs, which are evidently the most suitable animals for experiments relating to the formation of fat, Drs. Lawes and Gilbert conclusively show that, with foods in which the ratio of the nitrogenous to the non-nitrogenous constituents was a suitable one for fattening purposes—as in Indian corn and barley—a large proportion of the fat in the stored-up increase must have been produced at the expense of the non-nitrogenous constituents. There was also evidence that the nitrogenous constituents of the food, when in excess, might replace the carbo-hydrates, to some extent, in the formation of fat.

The analysis of the entire bodies and parts of the ten animals made at Rothamsted furnish some interesting data in regard to the composition of the animal food consumed by man. It has been generally assumed that the effect of animal food, in human dietaries, is to increase the proportion of the nitrogenous constituents: from the results of these analyses, however, we can not escape the conclusion that the animal elements of a diet, as a whole, increase the proportions of the carbo-hydrates or non-nitrogenous constituents. It appears that two thirds of the nitrogen of the entire body, of the calf and bullocks, was found in the carcass, and of this twelve parts were in the bones, leaving fifty-four per cent of the whole nitrogen of the body in the soft parts of the carcass. Of the thirty-three per cent of the nitrogen of the entire body in the offal parts, it was estimated that in the calf seven to eight parts, and in the oxen four to five parts, would be consumed as human food. Of the total fat of the body, about seventy per cent in the calf, and rather more than seventy-five per cent in the oxen, were found in the carcass. Of the fat contained in the offal parts, it was estimated that five sixths in the calf and one fifth in the oxen would be consumed as human food. The percentage of the total nitrogenous and total non-nitrogenous constituents of animals, included in the food of man, has been tabulated by Drs. Lawes and Gilbert as follows:

ANIMALS.	Per cent consumed as human food.	
	Of the total nitrogenous compounds of the body.	Of the total fat of the body.
Calves	60	95
Oxen	60	80
Lambs	50	95
Sheep	50	75
Pigs	78	90

According to this estimate, "there would be, in the fat calf analyzed, 1½ time, in the fat ox 2¾ times, in the fat lamb, fat sheep, and fat pig nearly 4½ times, and in the very fat sheep 6¼ times as much dry fat as dry nitrogenous constituents" in the parts of the animals consumed as human food. As one part of fat is equivalent to two and one half parts of starch, as a source of potential energy which must be taken as the measure of nutritive value, it will be necessary to estimate the fat in its equivalent as starch in making a comparison of vegetable and animal foods with reference to their nutritive value, and the relative ratio of their nitrogenous and non-nitrogenous constituents. On this basis the results of the Rothamsted analyses have been tabulated as follows:

RATIOS.

DESCRIPTION OF ANIMALS.	Proportion of dry fat to 1 of dry nitrogenous compounds.		Proportion of starch-equivalent of fat to 1 of dry nitrogenous compounds.	
	In carcasses, including bone.	In estimated consumed portions of the animals.	In carcasses, including bone.	In estimated consumed portions of the animals.
Store, lean and half-fat animals:				
Store sheep	1·64	....	4·09	....
Store pig	2·01	....	5·02	....
Half-fat ox	1·27	1·53	3·17	3·83
Half-fat old sheep	2·11	2·51	5·27	6·28
Fat and very fat animals:				
Fat calf	1·00	1·54	2·49	3·85
Fat ox	2·31	2·76	5·78	6·91
Fat lamb	3·39	4·40	8·49	11·01
Fat sheep	3.96	4·37	9·89	10·93
Very fat sheep	6·07	6·28	15·18	15·69
Fat pig	4·71	4·48	11·77	11·20
Means:				
Store and half-fat animals	1·76	2·02	4·39	5.05
Fat and very fat animals	3·57	3·97	8·93	9 93
Of the ten animals analyzed	2·85	3·48	7·11	8·71

For comparison with these ratios of the nutritive constituents of animal foods, wheat-flour bread was selected as one of the most important of the representative articles of vegetable food. The fat in the bread itself, estimated at one per cent, which is probably above the average, was reckoned in its equivalent of starch, and the ratio of nitrogenous and non-nitrogenous constituents was then found to be 1 to 6·8. Of the animals fattened for the butcher's use, the fat calf, only, gives a smaller proportion of non-nitrogenous constituents than the bread; the fat ox has nearly the same, and the other animals very much more. The averages also show that beef, mutton, and pork, on the whole, are not deficient in carbo-hydrates or non-nitrogenous nutritive constituents. After a full discussion of the subject, Drs. Lawes and Gilbert come to the conclusion that the great advantage of a mixed bread and meat diet, over one of bread alone, does not depend on the nitrogenous substance, but rather in substituting fat for a portion of the starch of vegetables. From the greater value of fat as a source of energy, and the general advantages of a variety of nutritive elements in the composition of a diet, this view of the influence of animal food seems to be well founded.

The limits of this article will not allow us to notice the experiments with sewage, and the feeding value of sewage-grown crops in the production of meat and milk; or the milling products of grain grown under a variety of conditions, and other special subjects of investigation, that have been included in the work at Rothamsted.

It is perhaps worthy of notice that nitrogen was the prominent object of interest in the Rothamsted field experiments, while the carbo-hydrates or non-nitrogenous constituents of the food seemed to be the ruling elements in the feeding experiments. Is this apparent contrast in the materials required as leading factors in the economy of plants and animals a mere coincidence arising from the methods of investigation, or does it represent one of the correlations of organic life concerned in the conservation of energy? The mineral and nitrogenous constituents of plants are taken up by their roots from the soil, which is almost, if not quite, the exclusive source of these elements of plant-growth, while all of the carbon is elaborated by the leaves from the supplies in the atmosphere. The mineral and nitrogenous constituents of the food of animals, on the other hand, are all discharged from the system, after performing their functions, in the liquid and solid excretions, and thus find their way to the soil, where they can be appropriated as plant-food; while a large proportion of the carbo-hydrates are exhaled in respiration as carbonic acid, the atmospheric food of plants. By this constant circulation in their appropriate channels the conservation of the nutrient elements, of both plants and animals, is fully maintained.

The legitimate objects of agricultural experiments are too often overlooked, and it is certainly a satisfaction, in a review of experiments that have been systematically prosecuted for so many years, on such an extended scale, to find that they have been fully appreciated throughout the entire work. In one of the first reports of experiments at Rothamsted, on turnip-culture, published in 1847, it is said, "The object of the experiments has not been the production of immense crops, but to trace, as far as we were able, the real conditions of growth required by the turnip, and to distinguish these from those of the crops to which it is, to a great extent, subservient." In this endeavor to trace the laws which underlie the phenomena under investigation, results of permanent value have been secured; and the practical benefits, measured in pecuniary values, which have been derived from them are of greater importance from the fact that they are not merely empirical and detached facts that are true only under certain conditions, but have a foundation in principles of general application. Too often experiments are made in which the practical or pecuniary ends are the direct and immediate objects of inquiry, but such efforts, in the main, must result in disappointment, so far as any permanent interest is concerned, from the failure to trace the results obtained to their appropriate causes.

The work so well begun at Rothamsted is now carried on with undiminished energy, with a prospect of still more important results in the future. Dr. Lawes is now expending in his experiments more than $15,000 annually. A new building will be erected next year to relieve the laboratory from its accumulated stores of samples, that have a definite history and form the materials for future investigations. From five to nine hundred samples of the ash of experimental crops are collected each year, and with each sample of ash there is a duplicate plant that is dried and bottled. With the true spirit of an original investigator, who sees that there is more to be learned than has already been discovered, and with a modesty that well becomes one who has accomplished so much, Dr. Lawes (now Sir John Bennet Lawes) writes me: "We are getting greatly in arrears of what may be called published work, and both Dr. Gilbert and myself are much more interested in searching after the unknown than in making public what little we do know. I think, however, it is not right to keep back so much valuable matter, and I shall try and publish next year the whole series of our ash analysis, without comment of any sort, merely giving the history of the experiments in regard to manures, etc., so that the reader may be able to trace the remarkable changes which take place from time to time. You will see that we have got to a point in our experiments in which the mere growth of the crop is one item, and a very small one, in the scope of our inquiry; the relations of the crop to the manure and to the soil and atmosphere bring us face to face with problems of great difficulty, which require several life-times to elucidate."

RECENT ADVANCES IN PHOTOGRAPHY.*

By Captain ABNEY, R. E., F. R. S.

TAKING the case of a daguerreotype plate which has been exposed, and which we are about to develop by the action of mercury, I should like you to understand exactly what takes place in the plate when it is exposed and developed. On the surface of the plate we have a mixture of silver iodide and bromide; but, for simplicity's sake, I will suppose that it is simply silver iodide. When light acts on such a compound, the result is the liberation of iodine and the formation of a new salt, which we call silver subiodide, $Ag_2I_2 = Ag_2I + I$. The iodine is taken up by the silver plate at the back of the sensitive film. To develop the picture, mercury-vapor is caused to condense on the subiodide, and leave the iodide intact. In the Talbotype process, the picture, which has been taken on a paper that has been washed with nitrate of silver, iodide of potassium, and nitrate of silver again, is developed by washing with gallic acid and silver nitrate. The picture begins to appear on washing after a very short exposure to the light, and becomes gradually more visible as the washing goes on. A paper process is a most fascinating process, because you can dabble about, and do exactly what you like; it is not like the gelatine plates of the present day, which you have to leave to come out mechanically. With paper, if you want to bring out a little better detail in one place,

* Abstract of four Cantor Lectures delivered before the Society of Arts.

you can dab it out, and, if you want to keep it back, you can put a little water over the place. There is no process like the paper process to please an artist. Now, what is the meaning of the development in this process? This morning I was in my laboratory, and I saw lying on the bench a feeble negative which I had badly developed, and which I had fixed with hyposulphite of soda. On taking it up, I found the salt had crystallized over the surface in the most beautiful manner; and I do not think I could point out to you anything which would give you a better idea of what development is than those crystals. When you have silver precipitated from a solution by any means whatever, you have it always in a crystalline form, and, as all crystals possess polarity, so crystals of silver possess polarity; and where one silver particle is deposited, there another silver particle will deposit. I look upon this as a physical development; we have a crystalline action going on during development, and nothing else. The iodide of silver is altered into a subiodide, and this, like the pole of a magnet, attracts the precipitating silver, and from that time, where the silver is deposited, other crystals of silver are deposited. That is what I call physical development.

There is another kind of development which some call chemical development; it is shown by a change in the color or material of the substance acted upon, and not by a building-up process, such as we have just had illustrated. The process may be illustrated in the development, by means of silver nitrate, of a picture which has been printed on nitrate of uranium. The picture is formed by silver oxide reduced by the particles of uranium nitrate which have been acted upon by light, and by nothing else. The silver oxide reduced is an exact equivalent of the uranium salt which has been acted upon by light. This differs from the previous process in that the gallic acid, in the one case, reduces the silver solution to the state of metallic silver; and, in the other case, the uranious image itself reduces it to the state of silver oxide.

Another mode of development, called chemical development in Germany, may, I think, more properly be termed alkaline development. Its theory is, that when you have a strongly oxidizing agent in the presence of an alkali and a silver compound, solid or in solution, the last will be reduced to the metallic state. Such an oxidizing agent we have in pyrogallic acid, and the alkali generally used is ammonia. Now, this kind of reduction is evidently useless, unless it can discriminate between a compound which has been acted upon by light and one which has not. When pyrogallic acid is used, in order to make the discrimination, something more has to be added as a restrainer to cause the reduction inducing the change to take place only in the part acted upon by the light. A solution of the bromide of an alkali is generally used for this purpose. Without a restrainer, the tendency is for those parts to be first reduced, but the action extends to that which has not been acted upon by the light. It has been usually said that alkaline development is only available for bromide of silver, but my experience has taught me that iodide of silver is as amenable to alkaline development as the bromide, although not so rapidly, and that chloride is very amenable to it, and will give most beautiful pictures.

Another mode of development, now very much in vogue, is that with ferrous oxalate. In this case we have an organic salt of iron in the ferrous state, which is capable of reducing silver bromide, iodide, and chloride to the metallic state, while itself is reduced to the ferric state. This process also requires a restrainer.

I have found a kindred developer, the use of which I consider one of the most recent advances in photography. It is an iron developer, which is capable of being used without any restrainer whatever. I call it ferrous citro-oxalate. It is made by adding to a solution of citrate of potash ferrous oxalate till no more will dissolve; the resulting compound is probably citrate of iron, but in a stronger form than is usually found.

Mr. Berkeley has lately introduced an improvement in the ordinary alkaline developer, in which he mixes with the pyrogallic-acid solution four times the weight of sulphite of soda. The action, apparently, is that the sulphite of soda absorbs the oxygen with greater avidity than does the pyrogallic acid, thus leaving that agent to do its work; consequently, we have a developer which remains uncolored for a very long period.

Another developer, which is competent to work also without a restrainer, but has not been used to a very great extent on account of its high price, is hydro-kinone. It is a much more powerful absorber of oxygen than pyrogallic acid, to such a degree that one grain of it is as active as two grains of that substance. Not requiring any restrainer, even when so troublesome a salt as silver chloride is used, it is able to give a better detail and allow a shorter exposure in the camera than when the ordinary alkaline developer is used. It is applicable to any plate with which you can work.

The next point to which I wish to call attention is the action of sensitizers. It may be proper first to explain what a sensitizer is. When you have chloride of silver exposed to light, you have a new compound formed, which is called subchloride, or argentous chloride ($Ag_2Cl_2 = Ag_2Cl + Cl$), and chlorine is liberated. This chlorine is very difficult to eliminate, if you do not give it something that can take it up; for instance, if you place perfectly pure chloride of silver *in vacuo*, without any trace of organic matter present, you will find that you get no darkening action, even if it is exposed to brilliant sunlight for months. If a white powder of the kind was submitted to you, to determine its character, you would say at once that it was not chloride of silver, because it was not darkened, since one of the tests of chloride of silver, among chemists, is that it shall darken in the light. Here I have a little bulb of it which was prepared, dried carefully, and sealed up. It has been exposed for months to the light, and is as pure a white as it was the first day it was put into the bulb. Another experiment was made at the same time; but, unfortunately, as I thought then, a small globule of mercury got into the vacuum, and was sealed up with the chloride; the consequence was that the chloride of silver immediately darkened: although the mercury was not in contact with the salt, the chlorine flew to the mercury, and formed chloride of mercury. This is an instructive experiment, showing that chloride of silver will darken merely in the presence of something that will mop up the chlorine. Silver iodide, when exposed to light, splits up into silver subiodide and iodine, and silver bromide into silver subbromide and bromine. Now, in order that there shall be a ready darkening of either of these salts, you must have something which will absorb the iodine or bromine (or, in the case of the latter, allow it to escape), according to the salt you expose to the light. This something is the sensitizer.

One point that has exercised the minds of a great many photographers is the illumination of their dark rooms. [The lecturer having shown the relation of the several parts of the solar spectrum with the absorption properties of different substances used in photography, proceeded to demonstrate the effect of differently colored glasses upon the passage of rays, and announced his conclusions.] If photographers want to have an absolutely safe light in developing their pictures, let them glaze their studios withc obalt glass and stained red, and they will get nothing but the light of that particular refrangibility, which will not affect any gelatine plate of the ordinary type. You may glaze and glaze with ruby, but you will never get rid of blue light entirely. Of course, it diminishes with every thickness you take. If you want to use ordinary plates, which are not so sensitive that you can not look at them, my advice is to use a combination of stained red and ruby glass, which will give you a comfortable light to work in, for it cuts off the blue and leaves the red in a brilliant patch. If the operator wishes to be still more secure, let him use a combination of cobalt glass and stained-red glass. A combination of red and green is a fairly safe light for iodide plates or ordinary plates, but not for gelatine plates, which are very sensitive. Next we come to a series of pretty colors, which may be very useful to us: magenta, with which the yellow is cut out entirely, and the green, leaving the blue, violet, and orange; aurine and chrysoidine, which cut off the blue; a combination of magenta and aurine, which gives a perfect red light, and is very good indeed for the photographic studio; and scarlet and aurine, which give the same effect. If all means of securing the right light fail, the photographer may use the ferrous oxalate developer, for you may bring the most sensitive plate out into a white light, when developing in a dish with a covering of that substance over it.

In 1874 the discovery was made that an increased action of the spectrum could be got by dyeing the film of sensitive collodion. If you take one of the aniline dyes and expose it to the light behind a piece of black paper, you get an image on the dye. What is the meaning of that? The meaning is, that the dye is oxidized, for, if you apply an oxidizing agent, you get the same result. Dr. Vogel found that if he dyed a plate with one of these fugitive dyes, he was able to obtain an extension of the impressed spectrum, and he introduced the term "optical sensitizer" to describe the fact. I object to the term, for it gives a wrong impression of the action that takes place, which is simply the reduction of the iodide or bromide of silver by the oxidation of the dye, and the provision of a nucleus on which development can take place.

Collodion emulsions have been in vogue for seven or eight years, although they have now been superseded, to a large extent, by gelatine emulsions. Whether the last be an improvement over the former process or not, the collodion process is admirably adapted for landscape-work. If the emulsion is of silver bromide or chloride, it is easily formed; an iodide emulsion is more difficult. The point in emulsion-making seems to be to get the precipitate in as fine particles as possible, and it is said that this can only be obtained, except at very great cost of time and trouble, by first adding the soluble bromide or iodide to the collodion. If you take the trouble to add the silver to the collodion first of all, the aspect of emulsion-making is entirely changed, and you can get any amount of fineness by adding the iodide or bromide to the silver contained in the collodion so long as you keep the silver nitrate in excess. If you put the iodide into the collodion first, and then add silver nitrate, you will find that you have precipitated the iodide of silver at the bottom of the bottle, and in a form which will not emulsify at all. My advice to those who wish to make collodion or gelatine emulsion is, to add the silver to the collodion or gelatine, and then add the haloid salts afterward, and you will get as perfect an emulsion as you choose.

It is a great comfort in the collodio-bromide process that the operator is able to give local intensity (a most desirable quality in all artistic work) to the image. I do not believe any process is perfect until that power is placed in the hands of the manipulator; and the great defect of the next process to be mentioned is, that it does not give that power, but leaves the operator at the mercy of his plate, on which he must let come out what will. This next process is the gelatine process, which may be described as one in which the silver bromide is held in suspension in gelatine in the same way that in the previous process it is held in collodion. Mr. Bennett showed how a gelatine emulsion can be made very sensitive by keeping it at a comparatively low temperature in a liquid condition for many days. Colonel Wortley afterward claimed that he could get the same sensitiveness by heating up to 150° Fahr. for a short time; and then Mr. Mansfield got it in a few minutes by boiling. Another method was then introduced by Dr. Monkhoven for the production of very sensitive gelatine emulsions by adding ammonia with the nitrate of silver. The ammonia process found many admirers, among them Dr. Eder, whose method of adding a large quantity of ammonia has given very sensitive pictures, and very vigorous ones when the sensitiveness is not too great. A process introduced by Mr. Cowan is even superior to that of Dr. Eder. He emulsifies his bromide in a very small quantity of gelatine with ammonia, and adds sufficient gelatine when the emulsion is ripened. Dr. Eder's method was to add the full amount of gelatine with the ammonia. Mr. Cowan's method gives greater rapidity and greater certainty.

What is the reason of the sensitiveness of the gelatine emulsion? Pictures can be taken with it in a tenth of the time necessary for a wet plate, and perhaps a thousandth of that necessary for an ordinary dry plate. The first reason is, that the emulsion has a blue form. Another reason is, that you can use a more powerful developer. If you separate bromide of silver which has been emulsified in gelatine, and place it in collodion, the extreme rapidity will be gone, for the simple reason that you can not use as strong a developer as you can with a gelatine emulsion; in fact, the property that gelatine possesses of acting as a physical restrainer comes into play: each little particle or aggregation of particles of the salt is surrounded by gelatine, which prevents the developer acting rapidly on them. Again, the fact that by boiling, or by the ammonia process, you get a coarser deposit of bromide of silver, also points to increased sensitiveness. Furthermore, if you boil or heat bromide, or any haloid salt of silver, with an organic substance, it has a tendency to separate into a metallic state; in fact, the bromide of silver is then in a state of very tottering equilibrium; the bromine is ready to be given off at the very slightest disturbance of the molecule, much more so than before it is boiled. I think that the fact that you so often get fogged emulsion when you overboil is proof of this statement. If you were to ask me to illustrate the sensitiveness of a gelatine plate, I should show you, not some of those marvelous instantaneous photographs, but a photograph by Mr. Henderson, by moonlight, and another of some under-ground cellars at Reigate, by Mr. William Brooks, taken by lamp-light. If anything can show what gelatine plates can do, it is the fact that candle-light and moonlight can be utilized for impressing the surface with an image. Dr. Vogel has recently introduced an emulsion made with acetic acid, gelatine, pyroxyline, and bromide of silver, which is very clean and very fairly rapid. Plates are more readily coated with it than with gelatine emulsion, but less so than with collodion emulsion.

Another very decided advance in photography is the doing away with glass as a support for the emulsion. Mr. Warnerke has perfected a process by which the photograph is taken on paper instead of on glass. He has a sensitive tissue which can be made of any length, and can be rolled on a roller and exposed in the dark slide. By turning another roller, a fresh surface is brought into the plane of the focusing-screen. The sensitive tissue is developed in the ordinary way with alkaline development. The film can be either stripped off, or else transferred to glass. In the latter case, we come to another point which marks a distinct advance. Mr. Warnerke has found that when you develop a gelatine plate with alkaline development, the parts which have been acted upon by light, and which have been developed, become insoluble in hot water. He is thus able, after development, instead of using the hyposulphite bath to fix the print, to transfer it to glass, and wash away with hot water the parts of the film which have not been acted upon by the light ; and he thus gets a transparency. To do this, it is necessary that the back surface of the gelatine film should be exposed to the water, as in carbon printing, and this is secured by transfer to glass. Mr. Warnerke is not satisfied with doing away with glass for the camera, but he does away with glass for printing ; and, in order to accomplish this, he retransfers the negative from the glass to a sheet of gelatine. I may say that the glass is freshly collodionized, and this enables the film to strip off readily. It is one of the advantages of these negatives that you can print from either side, each one yielding sharp points—a desideratum when using processes where reversed negatives are required. In the matter of gelatine films, we have Professor Stebbings's, which are really workable. The gelatine emulsion is apparently flowed on an insoluble film on glass, which is then stripped.

The next point I touch upon is the enlargement of negatives. The best way I know of, of getting an enlargement of a negative, is one that was brought forward a few years ago by Mr. Valentine Blanchard. He takes the original negative which he wishes to enlarge, and places it in an enlarging camera. He then takes a transparency of the exact size he wants his negative to be. He next takes a piece of common albumenized paper, and prints that transparency upon it, and by this means gets a very soft and beautiful negative. If you have a hard negative, it is almost impossible to get a soft transparency by the wet-plate process ; but, by this artifice of "printing out" your transparency and using that as a negative, you get a decidedly soft paper negative.

One of the new applications of the gelatine process is the development of a print on paper coated with gelatino-bromide. The paper is prepared by coating ordinary paper with gelatino-bromide (of the most sensitive kind, if you like). Such paper can then be exposed to the image formed by an ordinary magic-lantern ; by that means you can get an enlarged print. We may thus say that an advance has been made, when, by an ordinary magic-lantern, with a good negative, you can get a perfect enlarged print by development. Perhaps it will not have that luster which albumenized prints have, but it is a matter of taste whether you like that gloss or not.

As gelatine plates are now prepared they all have an excess of soluble bromide. While this is the case, the highest sensitiveness possible will not have been obtained. Dr. Eder has found that an increase of sensitiveness, two or three fold, may be produced by neutralizing this excess. The gelatine-plate makers have the problem to solve, how to get rid of any possible excess of soluble bromide in their films.

We will next consider what causes the destruction of the photographic image. You may destroy it by any substance which will readily part with oxygen. You can destroy it, for instance, by bichromate of potash, by any of the ferric salts, or by oxygen-yielding substances, like permanganate of potash, ozone, peroxide of hydrogen, or hydroxyl; in fact, there is hardly any substance which will part with oxygen, which will not destroy the developable image. The photographic image remains behind as a rule, though not always, but these re-agents prevent it becoming developable. Bromine also acts sometimes as a destructive agent, by escaping, when the exposure is too long, from the lower part of the bromide coating of the plate, and forming a fresh film of bromide at the surface after it has been acted on by the light.

A remarkable utilization of the oxidizing process has been proposed and carried out by M. Bolas. Wishing to reproduce an ordinary gelatine negative having the proper gradations of light and shade, he took a gelatine plate, immersed it in bichromate of potash, allowed the film to dry, and then exposed it to light behind the negative to be reproduced. In this exposure he had an oxidizing agent present in his film; the oxidized parts were acted upon by the light, leaving the other part intact; and by that means he got a reversed image. Oxidizing agents enable us also to get rid of fog. A gelatine plate, which has been fogged by exposure to light, can be cleared by immersing it in bichromate of potash.

I have learned in my experiments that halations, or the appearance of haloes around the picture can be prevented, by touching the back of the plate with asphaltum or some varnish; the reflection is toned down according to what medium is placed on the back of the plate. The most perfect cure for halation is Brunswick-black. It admits no reflection from the back of the plate, and thus enables the operator to get rid of every tendency to fuzziness of the image.

A most useful instrument has been introduced by Mr. Warnerke, which is known as a *sensitometer*, or measurer of sensitiveness. it consists of squares of colored gelatine of different opacities through which light is allowed to fall on a sensitive plate, and is intended as a guide to determine the comparative rapidity of the plates. Mr. Warnerke has also introduced an actinometer, or instrument to measure the intensity of light, which is dependent on phosphorescence for its value. It consists of a phosphorescent tablet, by the exposure of which to the action of light he is able to tell the photographic value of the particular light. The discovery is of the more value, because phosphorescence is induced by very nearly the same rays as those which affect bromide of silver. Another simple way of telling the amount of exposure to give the plates is by Woodbury's photometer, in which a piece of bromide paper exposed to the light is compared and read off with one of a series of tinted circles. A rule to be remembered in using this instrument is, that if a bromide plate is used, a bromide paper only should be used for securing the tint; if a chloride plate, a chloride paper. Recent researches of mine have shown that the darkening intensity and the developing intensity go hand in hand; therefore, when the operator has the number which gives the right tint, he may always be sure of getting the right exposure.

Some of the most recent and striking exemplifications of the scientific applications of photography are the composite photographs by Mr. Galton, which may be peculiarly useful in the study of anthropology. One of them is a typical family composite portrait composed of a mother and two daughters, in which all three faces are blended together. We are thus given a likeness of the female branch of the family; another, a blending of the father and mother, two sisters, and two brothers, gives the typical family group. Other pictures, in which the same principles are applied, give a typical group of engineer officers and a typical group of sappers.

SKETCH OF PROFESSOR HENRY DRAPER.

NO greater calamity could have befallen American science than the recent and sudden death of Professor Henry Draper. The news of it was an inexpressible shock to his friends, and was felt with painful regret by the whole community. But forty-five years of age, with the full promise of apparent health, and in the midst of an active and a brilliant career, he was cut off by an illness so short that but few had heard of it when his death was announced. In an excursion to the Rocky Mountains, in August and September, he had been subjected to severe exposure and contracted a heavy cold; he returned, however, in October, considerably recovered and able to resume his scientific labors. He gave a dinner to the National Academy of Sciences, at his residence, on November 16th, and made special and elaborate preparations for the occasion by electric illumination of the dining-hall in a way to produce some novel and agreeable effects. It is supposed that the anxiety and exertion of this preparation were more than he could well endure. He was attacked with severe pains in the chest, and suffered much while at dinner, but thought that he would get relief by a warm bath. But, instead of relief, his symptoms were aggravated, and a physician was sent for who recognized his attack as one of violent double pneumonia and pleurisy. It was hoped, however, that he might recover until shortly before his death, which occurred early in the morning on the 20th of November.

Henry Draper was born in Prince Edward County, Virginia, March 7, 1837, and two years later his father, Dr. John William Draper, removed to this city to take the chair of Chemistry in the New York University. Henry, at first, went through the course at the public school, but at the age of fifteen he entered the Academic Department of the university, though he did not graduate there. At the end of his sophomore year he entered the Medical Department of the university, which his father had been prominent in establishing, and from which he took his medical degree in 1858. He at first thought of practicing medicine, and received an appointment upon the medical staff of Bellevue Hospital, which he held for sixteen months, and then decided to abandon practice, and give himself to teaching. He was elected Professor of Physiology in the Academical Department of the university in 1860, and in 1866 became professor of the same branch in the University Medical School. He resigned this post in 1873, and afterward taught advanced analytical chemistry in the Academical Department of the institution. After the death of his father he was appointed to fill his chair, but previous to the opening of the last fall term he severed entirely his connection with the institution.

Professor Henry Draper is one of the men who is not to be interpreted in his individuality alone. With his father he represents one of the double stars in the firmament of scientific celebrities of which we have now a considerable catalogue. Among the illustrious pioneers of mathematical physics there are the Bernoullis, father and son; in chemistry, the Gmelins and the Brodies; in botany, the De Candolles and the Hookers; and, in astronomy, the Cassinis and the Herschels; and to these must be added the Drapers, father and son. Many more examples, though less eminent, might be given in which sons have distinguished themselves by pursuing with success the branches of research opened by their fathers, and to trace the influence that is exerted and the effects that are produced in these cases would be an interesting biographical study. In the present instance the son was the inheritor both of his father's genius and of his subjects of research, while his early education was shaped with a view to the pursuits to which his life was devoted. This point is thus referred to in the sketch of Henry Draper which appeared in a late number of "Harper's Weekly":

"He had for a companion, friend, and teacher, from childhood, one of the most thoroughly cultivated and original scientific men of the present age, who attended carefully to his instruction, and impressed upon him deeply the bent of his own mind in the direction of science. The boy was, in fact, immersed in science from his youngest years, and not merely crammed with its results, but saturated with its true spirit at the most impressible period. He was taught to love science for the interest of its inquiries, and was early put upon the line of original investigation in which he has won his celebrity. Henry Draper inherited not only his father's genius, but his problems of research. Dr. John W. Draper was an experimental investigator of such fertility of resources and such consummate skill that the European *savants* always deplored his proclivity to literary labors as a great loss to the scientific world. Henry Draper inherited from his father in an eminent degree the aptitude for delicate experimenting, and a fine capacity of manipulatory tact. The elder Draper was one of the founders of the recent science of photo-chemistry. He worked early and brilliantly in the new and fascinating field of the chemistry of light, and more than forty years ago by his extensive contributions to this subject he prepared the way for those who entered to reap the fruits of his labors in the splendid field of spectrum analysis. But the scepter was not to depart from the family. Henry pursued the same line of research, and by his extension of it will have a permanent place among the discoverers of the period."

Henry Draper's first important scientific investigation was made at the age of twenty, and was embodied in his graduating thesis at the Medical College. It was on the functions of the spleen, which was illustrated by microscopic photography—an art then in its infancy. Soon after receiving his degree he went to Europe, and while there visited the widely-known observatory of Lord Rosse, and studied the construction and working of his celebrated colossal reflecting telescope. This led him to consider the problem of using reflecting telescopes for the purpose of photographing celestial objects. On his return home he constructed a telescope of this kind of fifteen and a half inches aperture, and with it took a photograph of the moon fifty inches in diameter—the largest ever made. His success spurred him on to further improvements, so that he became an adept in grinding, polishing, and testing reflecting mirrors. An equatorial telescope was afterward constructed by him, with an aperture of twenty-eight inches, for his observatory at Hastings-on-the-Hudson. The instrument was wholly the work of his own hands, and was designed mainly to photograph the spectra of the stars. After a long series of experiments, it was finished in 1872, and has been pronounced by President Barnard as 'probably the most difficult and costly experiment in celestial chemistry ever made.' He was the first to obtain a photograph of the fixed lines in the spectra of stars, and he continued the work until he had obtained impressions of the spectra of more than one hundred stars.

When the commission was created by Congress for the purpose of observing the transit of Venus, in 1874, Professor Draper was intrusted with the charge of the photographic department. He spent much time in the preparations, for which he declined to receive any compensation. So signal was the success of his disinterested exertions, that the commissioners had a gold medal struck in his honor at the Philadelphia Mint, bearing the inscription, though in an extinct tongue, "He adds luster to ancestral glory." In 1878 he went to the Rocky Mountains to observe the total eclipse of the sun, and there successfully photographed the spectrum of the solar corona. For the last two or three years he had been much engaged in the difficult work of photographing nebulæ, and he startled the scientific world by the announcement that he had succeeded in getting a fine photograph of the great nebula in Orion and of its spectrum.

Professor Draper was not a prolific author, like his father, and only wrote one book; but he died in the prime of life, and had he lived would undoubtedly have given to the world the results of his ripened investigations in enduring treatises. He, however, wrote much for the scientific periodicals, describing the results of his work. He contributed several papers to the "American Journal of Science and Arts" and to "Nature." He published in 1864 a "Text-Book of Chemistry," and a paper on the "Philosophic Use of Silvered Glass Reflecting Telescopes." The paper was published in "The Philosophical Magazine." In the same year he published a pamphlet on "Silvered Glass Telescopes and Celestial Photography." "The Quarterly Journal of Science," in 1865, published his views of "Petroleum, its Importance and its History," and "American Contributions to the Spectrum Analysis." The Smithsonian Institution, in its "Contributions, vol. xiv., of 1864," published a paper on "Construction of Silvered Glass Telescopes, Fifteen and a Half-Inch Aperture, and their Use in Celestial Photography." The following papers have been published in "The American Journal of Science and Arts": "On the Diffraction Spectrum Photography," in 1872; "Astronomical Observations on the Atmosphere of the Rocky Mountains," and "Spectra of Venus and *a* Lyræ," in 1877; "Discovery of Oxygen in the Sun by Photography, and a New Theory of the Solar Spectrum," which was followed by another paper on the same subject, entitled "On the Coincidence of the Bright Lines of the Oxygen Spectrum with Bright Lines in the Solar Spectrum," in 1877; "Eclipse of the Sun in July, 1878," in 1878; "Photographing the Spectra of the Stars and Planets," in 1879; "Photograph of Jupiter's Spectrum," and "Photograph of the Nebula in Orion, on September 30, 1880," in

1880; and "Photograph of the Spectra of the Comet of June, 1881," last year.

Probably Henry Draper's most important work was his discovery of oxygen in the sun, which was duly chronicled and made a matter of discussion in "The Popular Science Monthly" at the time. It was the result of great sagacity, experimental skill, and an immense amount of labor. It was too unexpected and surprising to command the ready assent of eminent physicists and astronomers, while its experimental proofs were on such an expensive scale that the processes could not be easily repeated. But the opinion has undoubtedly gained strength that the discovery is valid, and by reference to a recent work by Professor Young on "The Sun" and the "Popular Astronomy" of Professor Newcomb, it will be seen that the weight of authoritative opinion is in favor of its reality.

Henry Draper was a man of medium height, rather stoutly built, with the appearance of vigorous health. His manners were agreeable, he was a lively and a witty talker, and a very fluent and instructive lecturer. He was enthusiastic in his passion for science, and persistent and tenacious in carrying out his elaborate plans of research.

In 1867 he married the daughter of Courtlandt Palmer, Esq., a cultivated lady who entered with a kindred enthusiasm into all his studies, and rendered the most faithful and efficient service in his delicate and arduous investigations. So thorough was her understanding of the problems he was engaged upon, and so considerable her share in the manipulatory practice, that it is hoped she may be able to complete and publish his more important unfinished work. At the death of his father-in-law, Professor Draper became a trustee of the large estate, and was henceforth much absorbed in business. But, though in command of very liberal means, his passion for science was too strong to be diverted by new solicitations, and he set a noble example by making use of his ample resources to carry on the work of scientific research on a scale that is but rarely attempted because of its great expense.

EDITOR'S TABLE.

THE BANQUET TO HERBERT SPENCER.

ALTHOUGH the visit of Mr. Spencer to this country has been in some respects painfully unsatisfactory, yet in other and the most important respects it has been most gratifying and successful. His state of health was such that he was good for nothing for social purposes. He has been long an invalid, and compelled much to restrict his social life at home. He left England in a bad condition, which was aggravated by his voyage, and then made worse by the exciting experiences of a new country, where he found many things very different from those he had been used to. Social intercourse was so exciting and exhausting that he was compelled to abstain from it, and many of his friends were sadly disappointed that they could not meet, welcome, and converse with him, as is the habit with other eminent strangers. This was a serious drawback upon his visit, equally to himself and to others, and will be a source of lasting regret.

But now that Mr. Spencer is gone, and has got home safely, everybody is glad he came. They are pleased that he has seen something of the country, if but little, and that he will have more correct and adequate ideas of what is going on here than if he had never come. It will be a fact of no small import, perhaps, in his mental history. But the chief significance and the most gratifying feature of his visit will be the way he has been received by the American public. If he has not been seen, he has been heard; and the wide effect is that he is both better known and more highly regarded by friends and enemies alike.

It had been determined by those interested in Mr. Spencer that some expression of public feeling should be made before he left, but it was long uncertain whether the state of his health would allow him to accept it. And, when at length he decided to do so, he at the same time found it necessary to shorten the time of his stay. This gave but a very limited opportunity to make the preparations for a banquet that should be at all adequate to express the interest of the occasion. Excellent dinners are, of course, very easy things to get up, and there are always plenty of fluent and sparkling speakers to add to them the pleasure of oratory. But there was something of seriousness in this affair that was not to be overlooked. We had with us, perhaps, the most eminent thinker in the world, and one whose name has now become identified with the greatest movement of thought in this age. It was every way desirable, therefore, that the demonstration should be made sincerely and even gravely expressive of American appreciation of Mr. Spencer's character, position, and work; and this was felt to be the more necessary as a bare act of justice, because his quiet and unobtrusive life has called forth no signal opportunities for the declaration of the profound regard entertained for him by many men of the highest intelligence. Representing no party or sect, supported by none of those associations that are so efficacious for the encouragement of talent, representing rather all that is most objectionable and unpopular in modern opinion, he has been left to the quietude of his solitary studies, and, while stamping himself deeply upon the mind of the period, he has been at the same time regarded as the most impersonal of men. This has undoubtedly had its advantages, and is not to be complained of. But it was very properly thought that, when he came to this country, where he is admired and venerated by multitudes who are indebted to him for light, awakening, and emancipation, there should be some formal and decisive utterance of what may be fairly taken as the American estimate of the man. In obedience to this sentiment, the best arrangements were made that the time would allow for speeches more thoughtful and even solid than are usual on such complimentary occasions. The wisdom of the policy was abundantly vindicated. The temper of the gathering required that the addresses should not only be interesting, but weighty with appreciation of the opportunity. The guest of the evening was received with enthusiasm, and listened to in utter silence, that not a word should be lost. All the other speakers were received with the most cordial applause; and when Mr. Beecher ended his stirring and whole-hearted address, at twelve o'clock, there was a fervid enthusiasm on the part of all that broke into a common expression of pleasure at the success of the affair. Many others there were ready, and would have been glad, had time allowed, to join in the emphatic tribute of respect and admiration for the distinguished guest.

It may be added that the only drawback upon the Spencer banquet was the large number of those who were disappointed in not being present. Had there been more time for preparation, the committee of arrangements would have chosen a place capable of seating five hundred, instead of two hundred, at table; though, had publicity been given to the affair through the press, the same difficulty would have occurred on a larger scale.

THE QUESTION OF OVERWORK.

In his address at the complimentary dinner tendered to him in New York, Mr. Spencer took up the subject of overwork—criticised the Americans as faulty in this respect, pointed out the evil consequences of excess in this direction, said that it implied an imperfect social ideal, and intimated that as a people we need more relaxation. His criticisms and advice have been generally received as sound and proper, but they have also elicited protests in various shapes, some of which it may be well to notice.

Mr. Spencer's countryman, George Jacob Holyoake, was recently honored with a reception in this city, and in his remarks he referred to Mr. Spencer's criticism dissentingly. He is reported as expressing great admiration of American activity and enterprise. As for the people being in too great a hurry, he thought Mr. Spencer himself would get to be in a hurry if he staid here six months, in the midst of opportunities and competitions that are enough to make an angel hurry. Shrewd Englishmen understand that Americans love to be told that they are smart and beat the world in enterprise.

But can so clear-headed a man as Mr. Holyoake fail to see that there is a special danger where the tendency to exertion becomes so irresistible—where individual impulses are only intensified by surrounding influences? The greater the temptation the greater is the peril of success, and the greater the need of restraint. Will it be said that there is no such thing possible as injurious overwork, or that the powerful strain upon men can be safely kept up without corresponding counteractions? The very question is absurd. The common experience of human nature testifies that men can very easily kill themselves by over-exertion. The problem is simply one of a proper balance between opposing tendencies. Where there is great stress in the direction of laborious activity, adequate counter-checks are demanded. Mr. Spencer did not so much condemn strenuous work, in which, indeed, he believes, as the lack of compensating recreations to countervail its mischievous effects.

Mr. Seymour Haden, another of Mr. Spencer's countrymen, in a complimentary reception speech, expressed also his quite emphatic disagreement with Spencer, and his admiration of the spirit of American enterprise and the splendid activity of the American people. As to the injury done by overwork, he did not believe in it, and the eminent physician, Sir William Gull, told him he had never known a man who had died from it. It is worry, not work, which kills, said Mr. Haden.

Undoubtedly, but is not the deadly worry one of the inevitable accompaniments and consequences of the overwork under the conditions of competitive enterprise in this country? It is work carried to such extremes as to engender anxiety and harassment under the fierceness of business struggles and the eagerness of unchecked ambition that is condemned. It is not claimed that the man who kills himself at fifty by unremitting labor has done it by too much physical exertion. He has done it by assiduous mental solicitudes without break or reaction, and the neglect of the conditions of health which that absorption of thought and strain of the feelings imply. Spencer's criticisms were leveled at the want of regulation and of a corrective in the shape of systematic relaxations that shall give more contrast in life, and greater freedom to the play of agreeable feeling, in place of the vexatious solicitudes which spring from devotion to work. To say that it is not overwork that kills, but the worry that is entailed, is merely to quibble with the subject. Sir William Gull might as well have declared that he had never known a case of death from cholera or consumption because it is the lack of power in the constitution to resist these diseases that is really the cause of death. It is only by such caviling that the notorious fact can be evaded, that thousands of men in this country sacrifice health and life to the passionate eagerness of business pursuits. Every observing person can give examples within the sphere of his own acquaintance of such premature breakdowns by the score.

The New York "Sun" gives an editorial to the subject, and maintains that the warning of Mr. Spencer is quite mistaken, as the Americans are far from being an overworked people. "There may be more fret and worry about money-making due to the haste to get rich, and the greater dissatisfaction with a position in mediocrity, but real overwork is not among our vices." But it would have been well to point out how "fret and worry about money-making," "haste to get rich," and "dissatisfaction with a position in mediocrity," operate to produce discretion in the regulation of our activities!

But the "Sun" gives expression to a criticism of Mr. Spencer which has been heard in various quarters, and requires attention. It intimates that he is under an objective illusion, and has simply generalized from his own morbidities to the condition of everybody else whom he saw. The editor says: "It is not at all remarkable that Mr. Herbert Spencer took this view of us, and that he made it the subject of the only speech he delivered while in the United States. Himself suffering from the lack of rest, he was naturally disposed to discover symptoms of the same trouble among the men in the strange country to which he had come on an unavailing search for repose. He had found in his American travels many nervous sufferers who could sympathize with him, just as every victim of a chronic malady, no matter how seemingly peculiar to himself, is sure to meet others who are more or less in the same state. His disease is naturally foremost in his thoughts, and his conversations are likely to lead up to it, so that he gets in the way of hearing of similar cases. There is a strong sympathy which brings together invalids of like kinds. They like to compare symptoms."

This is a very easy theory of the

case, but wholly groundless. Mr. Spencer is the last man to perpetrate a fallacy of this kind. He may be an invalid, but he is clear-headed enough to deal with this subject on its logical merits. When Mr. Schurz, at the dinner, made a reference to "dyspeptic philosophers"—although Spencer is a man of excellent digestion—Mr. Beecher aptly replied that, "at any rate, Spencer's books have no dyspepsia." It seems to have curiously occurred to many that the tables could be turned upon Mr. Spencer by referring to his own case, although for the life of us we can not see how his own experience of the very matter he was treating could have disqualified him from speaking upon it with pertinence and intelligence. But he did not choose to make it a personal matter, although if he had done so it would have redoubled the force of his argument. Mr. Spencer did undoubtedly break down badly, and long ago, and has suffered the painful consequences of it ever since.

But his invalidism has certainly been of a kind not to affect the clearness, rectitude, and soundness of his thought. His work for a quarter of a century is not only marvelous in its amount, but it is unparalleled in its originality, acuteness of insight, literary finish, and logical stability. No faintest taint can be traced anywhere in his books of the nervous exhaustion of their author. And the abundant reason is, that Spencer has followed his own prescription, and made relaxation, amusement, and recreation, in every form, a daily religious duty. By making work always subordinate to the unbending that is essential to its highest quality, he has proved the value of recreations as tributary, not only to length of life, but to the perfection of work. When, therefore, he spoke to the Americans upon the subject, and warned them of the dangers of their high-pressure civilization, we have no right to assume that there is any personal equation of unhealthiness on his part to be corrected. We are bound to take his advice as a sound thinker of unclouded discernment, and well disciplined in the work of drawing safe conclusions from discriminated facts.

But Mr. Spencer's argument is far from depending upon breakdown statistics that he may have observed or collected from others. The lesson that he inculcated is broadly derived from his social studies, and from his doctrine of the evolution of society. He pointed out that the social ideals of men are subject to change—that fighting as a universal passion has passed away, and that work as a universal passion has taken its place. In this there has been an enormous improvement, but the existing ideal is not a finality. It remains to take a further step forward by organizing more completely the means of human enjoyment. No advent of a poetical or prophesied millennium is to be expected, but men can nevertheless advance in this life to a happier state. And this becomes an immediate and practical question with every individual. The problem is only to be solved by making rational enjoyment, in larger measure, the object of life, and of each day in life. This is the proper end of knowledge and of work. It is true beyond question that the lives of immense multitudes in this country are narrowed down to the one absorbing gratification of money-getting, to the exclusion of all other gratifications. Of the nobler capacities of enjoyment they know nothing, and they have lost the power of even becoming interested in anything but the purpose that enslaves them. Can this be defended as a normal or satisfactory condition of the individual, or of a society largely composed of such individuals? Work is not an end, nor is study an end: work brings a surplus of means, and study should show how to use it for the most varied gratification—both should be tributary to completer and richer life.

No timelier or weightier message was ever delivered to a people than the farewell words of Herbert Spencer to the Americans on the eve of his departure from our shores.

THE BARTHOLDI STATUE.

Everybody has heard of the enormous statue of "Liberty Enlightening the World," now nearly completed by Bartholdi, the French sculptor, to be presented to the Americans for erection in the harbor of New York. It is of magnificent proportions, the figure being one hundred and forty-five feet in height, and is intended to stand upon a massive pedestal of equal height. The arm of the figure supports an uplifted torch which will be a brilliant electric light at an elevation of more than three hundred feet above tide-water. It will be a splendid object of art, and certainly embodies a grand idea, standing as it will at the port of the commercial metropolis of the United States—an impressive symbol of the progress of political liberty.

The statue has been constructed at the cost of a quarter of a million of dollars, which has been raised by the subscriptionsof a hundred thousand Frenchmen. It is to be presented by the great Republic of Europe to the great Republic of America, and its acceptance involves only the single condition that the American shall furnish a suitable foundation to support it. It will be ready for delivery and erection the coming summer, and it is therefore desirable to bestir ourselves to prepare for it. The pedestal is to be paid for, and will cost at least two hundred thousand dollars. There are a hundred American millionaires who would be delighted with the opportunity of defraying the whole expense if they could have the name of the donor engraved upon it in colossal letters, and thus make it a monument of selfishness, but it would be better to sink it in mid-ocean than to suffer its perversion in this way. It belongs to the American people to construct this pedestal, and it should be a burden upon nobody. Let half a dozen public-spirited and responsible men and women of each town organize themselves into a committee to obtain subscriptions from one dollar to twenty-five dollars, and the amount will soon be raised. It is no charity, and there needs to be no begging. There are plenty of people who would like to have a little stock in this new wonder of the world which will attract multitudes from the four quarters of the earth to behold it.

LITERARY NOTICES.

James Mill. A Biography. By Alexander Bain, LL. D. New York: Henry Holt & Co. Pp. 426. Price, $2.

The influence of John Stuart Mill upon the reputation of his father, James Mill, has been twofold: he has advertised him, and at the same time eclipsed him. It is frequently said of James Mill that his greatest work was John Mill; and there are many who suppose that this is his chief title to be remembered. Others think that, though the father may have been a man of some consideration in his time, yet that he has been so superseded by his son that all interest in him has disappeared.

But James Mill is not to be disposed of in this way. It is hardly questionable if James Mill is not, in fact, the greater and more original man of the two. If one is to be regarded as an appendage to the other, the order of time will correspond to the order of rank. No doubt the two Mills will have to be taken together as representative of one system of ideas. But the system, as such, belongs to the father much more than to the son. James Mill led in its development and John Mill followed. The son continued the father's work, expanding, extending, and elaborating it; but he inherited it as a half-constructed system, and, if the father was unable directly to give it its more developed form, he did it indirectly by educating his son entirely with reference to the fulfillment of his own mission as the founder of a new school of philosophy.

In seeking to rectify past judgments and to form a more just idea of the relative greatness of these two eminent men, we must remember, not only that the father was self-made, while John Stuart Mill had James Mill for a teacher, but we must remember also that the father had to make himself over again after he had at first been very bady constructed. He was educated as a clergyman in the orthodox school of Scotch Calvinism, and was of course early saturated with the whole order of ideas which belongs to that system. From this he got himself free by a total rejection of the whole body of theological belief that belongs to Christianity. He therefore began the reconstruction of his views and opinions late in life, and had to work them all out for himself. His son, on the contrary, had the immense advantage of beginning early a systematic training in the line which he pursued without a break through life. James Mill was an independent and indeed a masterly thinker in the fields of psychology, of political economy, of logic and the philosophy of government, and he was a pioneer of modern English liberalism. John Stuart Mill ran in upon all these subjects, revising, amplifying, and making them his own through the accomplishments of a wider erudition and a more thorough preparation; but if he had possessed more of his father's quality he would have broken loose from more of his father's errors, and the system of thought that is now identified with both names might have been made more enduring than it is.

Dr. Bain's life of James Mill is a very interesting book. It is interesting in its biographical features and as a delineation of a strong and remarkable character; and it is also especially instructive as a history of the times, as illustrated by the active and influential career of a man who had much to do with the reshaping of modern liberal opinion in social and political affairs. James Mill was a man of immense intellectual activity, as shown not only by the "Analysis of the Human Mind" and the "History of India," but by a host of lesser productions, such as articles contributed to cyclopædias and to many of the leading reviews, all of which were able in thought and written with remarkable clearness and force.

The Winners in Life's Race; or, the Great Backboned Family. By Arabella B. Buckley. New York: D. Appleton & Co. Pp. 367. Price, $1.50.

As a popular scientific writer the position of Miss Buckley is now assured. Her knowledge is sound, her judgment trustworthy, and her power of elementary exposition much above the common standard. Her first book, "A Short History of Natural Science," was needed and was well done. The "Fairy Land of Science" was also excellent. "Life and her Children" struck into the new biological path, and gave an interesting account of the *invertebrates*, or the lower forms of living creatures. The present work is a continuation of it into a higher field, although the present is an independent and self-explanatory work.

The work we now have from Miss Buckley was much demanded. We wanted a popular book on the *vertebrates*, the backboned family from the historic or evolution point of view. This made necessary unusual qualifications in the writer, and implied a knowledge of geology and paleontology, as well as natural history. Miss Buckley had been for many years the secretary and special student of Sir Charles Lyell, and had therefore the best opportunities to become familiar with those branches that have now become indispensable parts of biology. Miss Buckley says of the method of her book:

"I have therefore endeavored to describe graphically the early history of the backboned animals, so far as it is yet known to us, keep strictly to such broad facts as ought in these days to be familiar to every child and ordinarily well-educated person, if they are to have any true conception of natural history. At the same time I have dwelt, as fully as space would allow, upon the lives of such modern animals as best illustrate the present divisions of the vertebrates upon the earth; my object being rather to follow the tide of life, and sketch in broad outline how structure and habit have gone hand-in-hand in filling every available space with living beings, than to multiply descriptions of the various species. If my younger readers will try and become familiar with the types selected, either alive in zoölogical gardens or preserved in good museums, they will, I hope, acquire a very fair idea of the main branches of the Backboned Family."

This acceptance of the evolution standpoint, this tracing of the stream of life along the great course of terrestrial changes, this marking of the epochs of advancing organization in the ascending movement, and this tracing of genetic relationships, all concur in giving a new and impressive significance to the idea of unity in the great scheme of life, and give to natural history a new element of almost romantic interest. Miss Buckley has given attractiveness to the subject by her wealth of information, the clearness and simplicity of her descriptions, and she has heightened the effect by the skillfully conceived and finely executed illustrations with which the volume is filled.

Herbert Spencer on the Americans, and the Americans on Herbert Spencer. Being a Full Report of Mr. Spencer's Interview, and of the Proceedings at the Farewell Banquet. New York: D. Appleton & Co. Pp. 96. Price, ten cents, or $5 per hundred.

This pamphlet contains the most for the money of anything that can be found in the market. It has been carefully prepared, so as to be entirely correct and authentic. The newspaper reports were defective and incomplete. The revised addresses of Hon. William M. Evarts, Mr. Spencer, Professor W. G. Sumner, Mr. Carl Schurz, Professor O. C. Marsh, Mr. John Fiske, and Rev. Henry Ward Beecher are given in full; and to these are added the unspoken speeches of Mr. E. L. Youmans, Mr. Lester F. Ward, and Mr. E. R. Leland, together with all the letters sent to the committee, and which have not before been published. The document is weighty with important thought that can not fail to dispel much prejudice, and every one who cares for the dissemination of truth should send on his five dollars and get a hundred to distribute among his neighbors. They will be sure to appreciate the favor.

Unity Pulpit. Sermons of M. J. Savage. Vol. IV. No. 9. Herbert Spencer: his Influence on Religion and Morality. Published weekly. Boston: George H. Ellis. Price, $1.50 a year, or six cents single copy.

There is no more encouraging sign of the times than the indications we see that the pulpit is beginning to yield to the spirit of progress. As science slowly advances in the reformation of knowledge, bringing new subjects under the influence of its method, regenerating the ideals of mankind, and making truth the supreme object of quest and devotion, it is, of course, impossible for the pulpit to remain unaffected by the general movement. The highest victory of evolution will be to transform the biased preacher into the unbiased teacher. The pulpit, as we have inherited it, is becoming more and more anomalous in these times. It is the place that has been sacredly protected from the competitions of inquiry. Everywhere else error goes merely for what it is worth, and must take its chances in the open conflicts of discussion, but in the pulpit error is consecrated. It is the bulwark of tradition. Beliefs that are outgrown and abandoned everywhere else find refuge in the pulpit. The preacher is the expositor of ancient creeds, the leader of a sect, a rhetorical homilist, anything except an independent seeker after truth. The virtue of the pulpit is submissive faith, its crime freethinking. This characterization, of course, applies more to the past than to the present, but it is still too extensively true. There is, however, a silent, insidious, but inevitable change going on in a great number of pulpits that is loosening ancient prejudices, undermining past bigotries, softening theological asperities, and tending to a larger liberality in all religious matters. The position of the clergyman in a time of transition like the present is difficult, and, if he be a deeply conscientious as well as a clear-sighted man, is often painful. But many of them are learning how to meet the emergency, to yield gracefully that which must go, and to accept cordially that which must unavoidably come. Some pulpits, indeed, and their number is increasing, are already free. Their occupants are content to be simply teachers, and have liberated themselves from all trammels that tend to hinder the promulgation of truth. The doctrine of evolution will certainly sweep away a large amount of old belief that has hitherto been venerated by its religious associations, but in various qualified forms the essential truth of that doctrine is already acknowledged in many pulpits where it is sure, as time goes on, to yield its liberalizing fruits.

Unity pulpit, in Boston, occupied by the Rev. Minot J. Savage, has long been emancipated from those restraints of dogma which hinder the acceptance of the great truths established by science. Mr. Savage has met the new questions of the time without hesitation and with a cordial welcome, holding that neither will a sound morality be weakened nor pure religion suffer through the extensions of science and the enlargement of the domain of truth. He maintains rather that a more authoritative ethics and more ennobling religious conceptions must be the inevitable result of that progress of thought which now finds its highest expression in the evolution philosophy. Unity pulpit at any rate is free, and its occupant is unable to perceive why in his sphere of inquiry he should not have exactly the same liberty of investigation that is exercised by every member of the National Academy of Sciences. His last sermon, now before us, is devoted to Herbert Spencer, and to an estimate of his influence on religion and morality. It certainly can not be said that the pulpit has hitherto sinned in the way of neglecting this representative thinker; but the utterance of Mr. Savage differs so widely from what we have been accustomed to hear from the lips of clergymen, that we have pleasure in quoting its opening passages:

A quiet, modest, unassuming gentleman, with no assumption of greatness, with no air of pretense, with not the slightest approach to an appearance of patronage toward those who may be considered as less noted or great than himself, has been for the last two or three months seeking rest and refreshment here in America. Heard in public but once, seen in private only by a few, the country has still felt that a great man was here, a man like those to whom Emerson refers when he says, "A great man is himself an occasion." We have all felt this presence, and noted some indication of it now and then. For, when he has chosen to utter himself concerning the impressions that have been made upon him in this country, the whole nation has listened as though something were being said that was worthy of attention. The newspapers have caught it up; and all the leading organs for the expression of public opinion have commented on it, recognizing the fact that here at least was something not to be passed by in silence.

This man, to whom we have been so ready to listen, has during the last quarter of a century wrought a work that, I think I may say, without exaggeration, has no parallel in the history of human thought. He has so wrought himself into the very fiber, the warp and woof of this modern world, that I can say of him, what can be said of no other man living, and what has never been said of any man who has ever lived: he has made himself so vital a part of science, of philosophy, of education, of the science of government, of sociology, of ethics, of religion—he has so mastered and entered into the possession of all these great realms of human thought and human life, which in their totality almost make up what is meant by life itself, that to-day no serious and intelligent thinker can discuss any important question pertaining to any one of these departments without being compelled to reckon with Herbert Spencer. You can not discuss science, you can not discuss philosophy, you can not discuss education, politics, society, and the laws that underlie them, you can not discuss ethics, you can not touch the subject of religion, without either agreeing with or differing from this quiet scholar. And to have wrought himself so intimately and so essentially into the very life of the world—this, I say, is an achievement unparalleled in the history of human thought. I care not in which department you pick up a book to-day, you will find that the writer, if he comprehends his theme, is either working along the lines which Herbert Spencer has laid out, or else he is telling the world why he does not do so. He does not ignore him—he can not ignore him. About a week ago, it was my privilege and pleasure to join one or two hundred gentlemen in giving Mr. Spencer a public dinner in New York, on the eve of his departure. It was something striking and wonderful to see there the leading men of the nation in all departments of thought and culture, sitting at his feet and acknowledging his supremacy.

A Practical Treatise on Hernia. By Joseph H. Warren, M. D. Second and revised edition. With Illustrations. Boston: James R. Osgood & Co. Pp. 428. Price, $5.

The author of this book is widely known as a successful practitioner and writer on hernia and kindred affections, and his aim has been to make this a trustworthy work of reference on the subject. The first edition was received in the most favorable manner by the profession; the present new edition has been improved with all the advantages that further studies and continued experience in practice could enable the author to add. A new introduction has been written, and six new and carefully prepared chapters have been added, while a part of the old work, considered less essential, has been omitted. The volume contains a condensation of whatever seems most worth preserving from the world's literature on the subject, and much that is original with the author, embodying the results of his own studies for many years, and having never before been given to the public in a printed form. The treatise begins with a discussion of the causation of hernia, in fetal and infantile life and in adults, to which are added some remarks on its effects. Next are considered its kinds and frequency; its anatomy, descriptive and surgical, and strangulation. The essential purpose of the work is developed in the fifth chapter, in which the operations for hernia are considered generally; and the sixth, in which the author's own method is described and explained. Under the former head full justice is done to previous operators, all of whose methods that seem to have merit are candidly and impartially described and estimated; and acknowledgment is given for what the author has derived from them, particularly from Heaton's method, of which Dr. Warren's is a modification and improvement. The principle of Warren's method is the injection of an astringent solution to induce closure of the rings and canals, to produce what is commonly called a radical cure. This principle was suggested by Dr. Pancoast, of Philadelphia, extended and applied with much success by Dr. Heaton, and was brought to a higher degree of perfection by a more complete adaptation of the injecting instrument to the conditions required by the delicate tissues operated upon, and some modifications in the injected fluid, by Dr. Warren. All of the operations, from that of Chauliac to that of Wood, are declared to be "severe, and likely to be attended with great danger to life, if not absolute loss of it." No such arguments, Dr. Warren adds, "can be used against the operation that I recommend, as no fatal results have ever occurred in any of the operations performed by the various surgeons who have undertaken them"; and the only losses likely to occur, he intimates, are from blunders and awkwardness. He is particularly at pains to demonstrate that no danger of peritonitis, so much feared by physicians, is incurred in it. A great deal, however, is acknowledged to depend on the proper selection of cases to be operated upon. Heaton's great success may be largely ascribed to the discrimination he exercised in this matter, and we are told that "when speaking of his invariable success, he was in the habit of giving me a peculiar wise and knowing look of the eye, and he would say that he cured all, or about all, that he *would* operate on." The general health of the patient has, of course, much to do with the success of the operation, and something depends on the kind of hernia. The succeeding chapters to those on operations are devoted to the treatment of strangulated hernia, kelotomy, or herniotomy, "Artificial Anus and Wounds of the Intestines," hydrocele and varicocele, some observations on trusses which might be made of general application, copious accounts of cases, an extensive bibliography, and a list of operators. The work is presented by the publishers in excellent shape, with the best of paper and print, and an abundance of clearly delineated illustrations.

Proceedings of the Biological Society of Washington. Vol. I. Washington: Printed for the Society. (G. Brown Goode, Secretary.) Pp. 110.

This volume contains the constitution of the society, the list of honorary, corresponding, and active members, and the proceedings from the first meeting, for organization, November 19, 1880, to May 26, 1882. In addition are given in full the addresses delivered on the occasion of the Darwin Memorial Meeting, May 12, 1882, comprising "The Doctrine of Darwin," by Theodore Gill; a "Biographical Sketch," by William H. Dall; "Darwin's Work in Entomology," by Dr. Riley; "Darwin as a Botanist," by Lester F. Ward; "Darwin on the Expression of the Emotions," by Frank Baker, M. D.; and "A Darwinian Bibliography," by Frederick W. True. President Gill's inaugural address of 1881, on "The Proper Use of the Term Biology," is also published in full.

A Guide to Modern English History. By William Cory. Part II, 1830 to 1835. New York: Henry Holt & Co. Pp. 567. Price, $3.50.

The first part of this work related to the first fifteen years of the great peace. The expansion of the present volume, which includes only about a third as much time, is justified by the author, on the ground of the "excessive value of the work done for the British Commonwealth in the years now surveyed." These years, the author adds, "are full of the virtue and wisdom which make modern England supremely worthy of a student's contemplation; it seems not too much to say that they form a period of paramount importance in the history of legislation and government." The work is the composition of a sharp observer, and is marked by vigorous thought and forcible expression, and a bold, captivating style that engages the reader and holds him. Mr. Samuel R. Gardiner, who may be regarded as an expert in the specialty of English history, characterizes it as "one not very well calculated to guide those who do not know a good deal of the way already, but admirably fitted to enable those who do to test those opinions which they have sometimes too hastily formed."

Address delivered by Edward Atkinson at the Opening of the Second Annual Fair of the New England Manufacturers' and Mechanics' Institute in Boston, September, 6, 1882. Pp. 32.

The end to be subserved by such industrial exhibitions, Mr. Atkinson tells us, is to make less arduous the daily work whereby the larger part of the community earn their daily bread. The author is not one who takes a pessimist's view of life, and, although he shows that the measure of comfort that each man, woman, and child can yet enjoy, even in our prosperous land, does not exceed on an average fifty or sixty cents per day, he does not think or believe that increase of wealth is of necessity complemented by increase of poverty. Still the small minority of people who can become possessors of capital in any large measure must justify the leisure which they or their fathers have earned, by the use which they make of the time and means at their disposal. After showing how it is possible for our railroad kings to put money in our pockets while amassing fortunes themselves, he compares our happy lot with the unfortunate condition, from an economic point of view, of those countries that are burdened by huge standing armies, and where the quantity produced, although relatively less, must be divided among a greater number. The advantages of developing the hand and brain together are then referred to. The last man or woman whom you desire to discharge from the works which you control, when the times are hard, is the one earning the most for himself or herself; the first to be discharged is the unfortunate one whose hand and brain have not been developed together, and who can, in hard times, no longer render you a service, even if paid a sum barely sufficient to support life. "Owing to the great natural, social, and political advantages that we enjoy, the wages of labor and the remuneration of capital must be greater in proportion to the effort used than in any other section of the world's surface; and these facts prove that the cost of production is less in ratio to product than it can be anywhere else."

Although intended for delivery before a limited audience on a particular occasion, the address is of such general interest as to deserve a wide circulation.

Contributions to Mineralogy. By F. A. Genth. Read before the American Philosophical Society, August 18, 1882.

This pamphlet of twenty-four finely-printed pages represents a large amount of actual labor, and contains several important contributions to science, in the form of analyses and observations on altered minerals. That one mineral should be gradually changed, particle by particle, molecule by molecule, into a different mineral having other chemical and physical properties, is a curious and interesting phenomenon, worthy the study of such a chemist as Professor Genth. The first case described is the alteration of corundum, in Madison County, North Carolina; it is found partially altered to a massive greenish-black spinel; in Towns County, Georgia, a pink corundum is found surrounded by greenish-white, cleavable zoisite; an interesting occurrence of the alteration of corundum into a feldspar is near Media, Pennsylvania, at the "Black-

Horse" tavern; Haywood County, North Carolina, has furnished specimens of corundum altered into feldspar, as well as mica; examples of corundum altered into margarite (calcium mica), cases of the alteration of corundum into fibrolite and cyanite are also mentioned. The altered minerals were more or less water-worn and rounded, while the corundum which they inclose is sharp and angular, which proves that since the great gravel deposits were formed no alteration of the corundum has taken place in these deposits.

The other interesting alterations described by Professor Genth are the alteration of orthoclase into albite, and talc into anthophyllite, and pseudomorphs of talc after magnetite. Several other investigations of mineral species follow, among them gahnite, rutile and zircon, sphalerite and prehnite, pyrophyllite, beryl, niccolite, and artificial alisonite. The author also describes the accidental formation of artificial crystals of rutile during fusion with potassium hydrogen sulphate; two crystals of octahedrite were likewise produced at the same time, and had a decided blue color.

On the Age of the Tejon Rocks of California, and the Occurrence of Ammonitic Remains in Tertiary Deposits. By Angelo Heilprin. From "Proceedings of the Academy of Natural Sciences of Philadelphia," July, 1882.

The author undertakes to settle the point in dispute between Conrad and Gabb, as to the age of the Tejon rocks, referred by the former to the Eocene series, and by the latter to the Cretaceous. A list of one hundred and twelve species is given, representing the fauna of the Tejon group with the various localities of occurrence, as claimed by Gabb, and evidence presented to show that Gabb was in error in many cases, and hence that the tables do not afford a safe criterion for the solution of the problem. The author then goes on to show that, of the seventy-seven genera represented in the Tejon group, at the very least twenty-two are more or less distinctively Tertiary, and out of these eleven are not positively known to have appeared before that geological epoch. Also that, with the exception of six or seven fragments of *Ammonitidæ*, there is not a single distinctively Cretaceous generic type in the entire number. He therefore concludes that the rocks of the Tejon group, despite their comprising in their contained faunas a limited number of forms from the subjacent (cretaceous) deposits, and a few undoubted representatives of the *Ammonitidæ*, are of Tertiary (Eocene) age.

The Eocene age of the Tejon rocks is likewise maintained by Professor Jules Marcou, who made a personal examination of the region.

Proceedings of the Davenport Academy of Natural Sciences. Vol. III, Part II. Davenport, Iowa: Published by the Academy. Pp. 192, with Four Plates.

The present number contains the proceedings of the Academy during 1879 and 1880, with the president's addresses of Mrs. M. L. D. Putnam and Mr. W. H. Pratt. The numerous papers testify to the great activity of the members of the Academy in the leading departments of investigation, predominantly in archæology, to the study of which the location of the society offers excellent facilities. A very interesting paper is that of Professor G. Seyffarth on the inscriptions of the Davenport Tablets, the conclusions of which are startling for their boldness.

How to Succeed: A Series of Essays by Various Authors. Edited by the Rev. Lyman Abbott, D. D. New York: G. P. Putnam's Sons. Pp. 131. Price, 50 cents.

This is a republication of a series of papers which appeared last winter in the "Christian Union," on the general subject and its applications, headed with articles by Senators Bayard and Edmunds on "Success in Public Life," and continued with other articles, by men who have attained eminence in their various professions or arts, on the elements of success in their respective callings.

Cerebral Hyperæmia: Does it exist? A Consideration of some Views of Dr. William A. Hammond. By C. F. Buckley, B. A., M. D., formerly Superintendent of Haydock Lodge Asylum, England. New York: G. P. Putnam's Sons. Pp. 129.

The author opposes the theory which Dr. Hammond has published concerning the effects of excess or deficiency of blood in the brain with an earnestness which it is safe to call extreme. He assails with controversial ardor the logic of Dr. Hammond's views, and endeavors to show that they are inconsistent with themselves, and are not supported by the facts whence they are drawn, or by the authors from whose works Dr. Hammond has endeavored to substantiate particular points of his theory.

The Solution of the Pyramid Problem, or Pyramid Discoveries, with a New Theory as to their Ancient Use. By Robert Ballard, of Queensland. New York: John Wiley & Sons. 1882. Pp. 109.

Mr. Ballard is not the first who has advanced a theory as to the purpose for which the pyramids were built, nor even the first to conjecture that they were of use in resurveying the land after the annual inundations of the Nile. "Built by scientific men, well versed in geometry, these great stone monuments are so suited in shape for the purposes of land-surveying, that the practical engineer or surveyor must, after consideration, admit that they may have been built mainly for this purpose." The author also thinks that he has discovered the unit of measure used in their construction, and to which he gives the name of Royal Babylonian cubit. This cubit he makes equal to 20·22 British inches, and as there are 77,760,000 royal Babylonian cubits to the polar circumference of the earth, the cubit represents the $\frac{1}{60}$ of a second. This he claims is the most perfect ancient measure yet discovered. It is a perfect, natural, and convenient measure which fits the plan of the pyramids and fits the circumference of the earth. The author also states that the pyramid of Cheops is situated on one acute angle of a right-angled triangle, and the pyramid called Mycerinus is on the other acute angle, the other two sides of which run respectively east and south from these pyramids. The sides of this triangle are respectively 3, 4, and 5. The pyramids of Cheops and Cephren are situated on the acute angles of a still more remarkable triangle, the sides of which are to each other as 20, 21, and 29. Many other curious facts are mentioned regarding the dimensions, position, and slope of the pyramids, and a description of the method in which the author supposes them to have been used as the "theodolites of the Egyptians." Many of the obelisks, he thinks, were probably marks on pyramid lines of survey, and the pyramid may have been a development of the obelisk for this purpose.

A Guide to Collodio-Etching. By Benjamin Hartley. Illustrated by the author. New York: The Industrial Publication Company. Pp. 48, with Six Plates.

This little work is for the benefit of amateurs, who feel the need of some simple and inexpensive method of duplicating their sketches and studies for the benefit of their friends. The various methods by lithography, photography, and the photo-engraving of pen-and-ink drawings which have been suggested by different persons, have been found by the author to be inconvenient, expensive, and troublesome. He describes, as more nearly realizing than any other one the conditions required by the amateur, a process for drawing the sketch with a needle upon the glass plate, as prepared by the photographer for the camera, and printing from the etching as an ordinary photograph is printed. He undertakes to give all the practical information necessary on the subject, so that persons who know nothing about photography may be able to carry into effect all the details of his system.

United States Commission of Fish and Fisheries. Report of the Commissioner for 1879. Washington: Government Printing-Office. Pp. 846.

The report embraces an inquiry into the history and statistics of food-fishes, and a summary of what has been accomplished in the matter of their propagation in the waters of the United States. Among the collateral subjects of attention by the commission have been an investigation into the chemical composition of fish under the varying circumstances of age, sex, and the condition of the reproductive apparatus; researches into the temperature of fishes, experiments in the production of cold for the preservation of fish, and the preparation of a series of casts in plaster and *papier-maché* of the larger species. The pole-flounder, which was discovered off the coast of New England in 1877, proves to be one of the most abundant of the flat-fish family, and promises to be an important addition to the food resources of the country. A second species of fish, known as the tile-fish, and constituting a genus and species entirely new to science, was discovered during the summer of 1879. The most important item of the year in the work of propagation was the beginning of the distribution of young carp to various points in the United States. The demand for the fish was very great, even with a relatively small supply, and the calls increased so rapidly that it became doubtful whether, even with a much larger production, all the requirements could be met. Good progress is reported in the propagation and distribution of salmon and trout of the various species, shad, codfish, and striped bass. Among the valuable papers with which the report proper is supplemented are one by Professor W. G. Farlow, on the "Marine Algæ of New England," containing technical descriptions of all the known species; an account of the cephalopods of the northeastern coast of America, by A. E. Verrill; and articles on the propagation of the eel, the food of marine animals, the Iceland herring fisheries, the periodicity of the great herring-fisheries, the herring's mode of life, the fisheries of the west coast of South America, the scientific examination of the German seas, the effects of sawdust and the pollution of waters by factory refuse on fishes; and articles and reports bearing upon more special features of fish propagation.

The Gulf Stream. Additional Data from the Investigations of the Coast and Geodetic Steamer Blake. By Commander J. R. Bartlett. Pp. 16.

This publication embodies the substance of a paper which was read by the author before the American Geographical Society, and is supplementary to a previous paper. The author states that he is "not hampered with any theories," and merely gives his deductions from the actual facts obtained by the Blake's party, which may serve to correct a few popular errors, even if they do not throw much new light on the subject. His principal conclusions have already been noticed in "The Popular Science Monthly."

Proceedings of the Department of Superintendence of the National Educational Association, March 21 to 23, 1882. Washington: Government Printing-Office. Pp. 112.

Value is added to the report of the ordinary discussions of this body by the papers of Drs. Billings and Charles Smart relating to "Ventilation"; of the Hon. H. S. Jones on "Obstacles in the Way of a Better Primary Education"; of Professor G. Stanley Hall on "Chairs of Pedagogy in our Higher Institutions of Learning"; of Drs. A. D. Mayo and J. L. M. Curry on "National Aid to Education"; of Dr. Sheldon Jackson on "Education (or the Want of it) in Alaska"; of Dr. John M. Gregory on the "Common-School Studies."

Putnam's Art Hand-Books. Edited by Susan N. Carter. Drawing in Black-and-White.—Sketching in Water-Colors. New York: G. P. Putnam's Sons. Pp. 55 and 69. Price, 50 cents each.

The first manual, by the editor, is an effort to show beginners "why they had best choose one material in black-and-white, or another; and to tell them, by a few plain directions, how they can best manage their charcoals, crayons, pen-and-ink, or lead-pencils." The directions are clear, and are complemented by typical illustrations, from masters, in each of the styles; but it would be better, perhaps, if the directions and illustrations were more conformed to each other. The second book is by Thomas Hatton, and is intended for the use of such students "as are accustomed to copy water-color drawings, and find no difficulty in sketching natural objects in black-and-white," yet need the instructions it undertakes to give them, to enable them to reproduce Nature expressively in her own colors.

A Dictionary of Music and Musicians. Edited by George Grove, D. C. L. Parts XV and XVI (Double Part). London and New York: Macmillan & Co. Pp. 272. Price, $2.

We have already called attention to the fullness and the other merits of this excellent work. The present double number contains the articles under the titles from "Schoberlechner" to "Sketches."

The "Hoffman Cover and Binder" is a very useful aid for the convenient handling and preservation of magazines and pamphlets while in use and afterward. It is a well-finished book-cover, so arranged that a magazine can be placed and fastened within it in a moment, so as to form a substantial bound book; then, when the next number arrives, can be taken out and replaced by the new one; or it can be left in and deposited as a single volume in the library. The magazine is thus kept in perfect order, whether it is intended to be bound with its fellow-numbers or filed singly. Six sizes are kept in stock, to accommodate the variously shaped publications from "The Popular Science Monthly" to "Harper's Weekly" or the "Illustrated London News," and other sizes will be furnished to order, by Joseph A. Hoffman, 208 Montgomery Street, San Francisco.

"The American Journal of Physiology" is a new monthly periodical, each number of which will consist of sixteen pages, edited and published by D. H. Fernandes, M. D., Indianapolis, Indiana. It is intended to supply what the editor believes to be a lack in American scientific literature, and is promised communications from several prominent specialists.

"The Modern Stenographic Journal" is a new Phonographic Magazine, published at Buffalo, New York, by George H. Thornton, editor, and Emory P. Close, associate editor. It will keep its readers in the current of what is going on in the stenographic world; will contain a department of instruction, with serial lessons, and a department devoted to the type-writer and calligraph; and will endeavor to popularize "a simple and rapid system of writing"

PUBLICATIONS RECEIVED.

Address before Section B (Physics) of the American Association for the Advancement of Science, at the Montreal Meeting. By T. C. Mendenhall. Salem, Mass., 1882. Pp. 14.

Test of Building Material, made at Watertown Arsenal, Mass., August, 1882. Philadelphia, 1882. Pp. 33.

Aberrations of Audibility of Fog-Signals. By Arnold B. Johnson. Washington: Judd & Detweiler, Printers. 1882. Pp. 14, with Two Maps.

The Longfellow Calendar for 1883, with Selections for Every Day in the Year. Boston: Houghton, Mifflin & Co.

Statement of Work done at the Harvard College Observatory during the Years 1877–1882. Pp. 23; and, A Plan for securing Observations of the Variable Stars. Pp. 15. By Edward C. Pickering. Cambridge: John Wilson & Son, 1882.

The Worship of the eciprocal Principles of Nature among the Ancient Hebrews. By J. P. MacLean. Cincinnati: Robert Clarke & Co. 1882. Pp. 23. 25 cents.

Seventh Annual Report of Johns Hopkins University. Baltimore, Md. 1882. Pp. 122.

"Paleontological Bulletin," No. 35. By Professor E. D. Cope. Philadelphia: A. E. Foote. 1882. Pp. 44.

Northern Transcontinental Survey. First Annual Report of Raphael Pumpelly, Director. New York: Wells Sackett & Rankin, Printers. 1882. Pp. 16.

Some Observations on Ostriches and Ostrich-Farming. Pp. 11.

Some Indications of an Early Race of Men in New England. By Henry W. Haynes. From the "Proceedings of the Boston Society of Natural History." Pp. 9.

On the Determination of the Flashing Point of Petroleum. By John T. Stoddard. Pp. 4.

Radiant Heat an Exception to the Second Law of Thermo-Dynamics. By H. T. Eddy, Ph. D. 1882. Pp. 10.

The Sense of Dizziness in Deaf-Mutes. By William James, M. D. Cambridge, 1882. Pp. 16.

Transactions of the Anthropological Society of Washington. From February, 1879, to January, 1882. Vol. I. Washington, 1882. Pp. 142.

Food Adulterations. By Professor Albert B. Prescott, M. D. Reprint from "Annual Report of Michigan State Board of Health for 1882." Pp. 6.

The Tides. By John Nader, Civil Engineer. 1879. Pp. 31.

Sketch of Lewis H. Morgan. By F. W. Putnam. From the "Proceedings of the American Academy of Arts and Sciences," May, 1882. Pp. 8.

Facts and Phases of Animal Life. By Vernon S. Morwood. Illustrated. New York: D. Appleton & Co. Pp. 286. Price, $1.50.

Winners in Life's Race; or, The Great Backboned Family. By Arabella B. Buckley. Illustrated. New York: D. Appleton & Co. Pp. 367. Price, $1.50.

Lectures on Art, delivered in Support of the Society for the Protection of Ancient Buildings By Reginald Stuart Poole and others. London: Macmillan & Co. Pp. 232. Price, $1.50.

Anatomical Technology as applied to the Domestic Cat. An Introduction to Human, Vertebrate, and Comparative Anatomy. By Burt G. Wilder and Simon H. Gage. New York and Chicago: A. S. Barnes & Co. Pp. 575. Price, $4.50.

The Life of James Clerk Maxwell, with a Selection from his Correspondence and Occasional Writings, and a Sketch of his Contributions to Science. By Lewis Campbell and William Garnett. London: Macmillan & Co. Pp. 662. Price, $6.

New Method of Learning the French Language. By F. Berger. New York: D. Appleton & Co. Pp. 138. Price, $1.

A Study, with Notes, of "The Princess" (Tennyson's poem). By S. E. Dawson. Montreal: Dawson Brothers. Pp. 120.

American Hero-Myths: A Study in the Native Religions of the Western Continent. By Daniel G. Brinton, M. D. Philadelphia: H. C. Watts & Co. Pp. 251. Price, $1.75.

Traits of Representative Men. By George W. Bungay. Illustrated. New York: Fowler & Wells. Pp. 286. Price, $1.50.

Charles Darwin. Memorial Notices, reprinted from "Nature." London: Macmillan & Co. Pp. 82. Price, 75 cents.

A Whimsical Wooing. By Anton Giulio Barili. From the Italian by Clara Bell. New York: William S. Gottsberger. Pp. 88.

Experimental Physiology. Its Benefits to Mankind. By Richard Owen, C. B., M. D., F. R. S., etc. London: Longmans, Green & Co. Pp. 216. Price, five shillings.

Youth: Its Care and Culture. By J. Mortimer Granville. New York: M. A. Holbrook & Co. Pp. 167.

The Scientific and Technical Reader. London: T. Nelson & Sons. Pp. 400. Price, 2*s.* 6*d.*

The Factors of Civilization, Real and Assumed. Considered in their Relation to Vice, Misery, Happiness, Unhappiness, and Progress. Vol. II. Atlanta, Georgia: James P. Harrison & Co. Pp. 359.

Text-Book of Geology. By Archibald Geikie. London: Macmillan & Co. Pp. 971. Price, $7.50.

The Coues Check-List of North American Birds. Second edition. Boston: Estes & Lauriat. Pp. 165.

The Diseases of the Liver, with and without Jaundice. By George Harley, M.D. Philadelphia: P. Blakiston, Son & Co. Pp. 751. Price, $5.

Novissimum Organon: The Certainties, Guesses, and Observations of John Thinking-machine. By James Ferdinand Mallinckrodt. St. Louis: Hugh R. Hildreth Printing Co. Pp. 116.

Quintus Claudius: A Romance of Imperial Rome. By Ernst Eckstein. From the German by Clara Bell. In two vols. New York: William S. Gottsberger. Pp. 616. Price, $1.75.

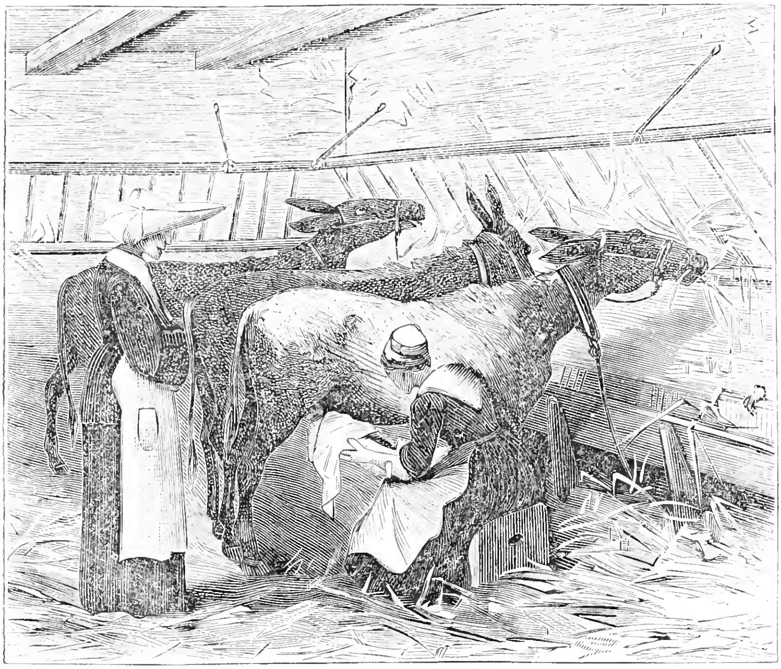
Dress and Care of the Feet. By Dr. P. Kahler. New York: G. P. Putnam's Sons. Pp. 39.

POPULAR MISCELLANY.

Mortality in Town and Country.—Professor Finkelnburg attempted to show, in a paper read at the recent Sanitary Congress in Cologne, that cities are not of necessity less healthy than country districts, and that, where they appear to be so, the fact can generally be attributed to local influences affecting the hygienic or economical condition of the population. The analysis and comparison of adult male and female mortality and infant mortality bring out many interesting facts. The male population of the cities is described as being less healthy than the female population, and liable to consumption and affections of the heart, brain, and kidneys. In Cologne, the mortality among women over thirty years of age is not only less than among men, but is less than the death-rate among women of the same ages in other parts of the Cologne district. Similar results are shown at Bonn. The deaths of men from consumption show a marked predominance in the centers of the textile and metal industries. The fact that a similar result appears in country districts where labor of a similar character is carried on is presumptive evidence that the mortality is associated with the industrial activity of the towns. Epidemic diseases seem to show an excessive urban mortality only in the case of young children. Infant mortality appears to reach its highest point where the population is most dense, and the proportion of female labor in the factories is most considerable. A more favorable condition, however, seems to prevail in those districts where domestic labor is general. It is proved with a certain amount of clearness that infant mortality varies according to the dwelling accommodation in towns and the amount of parental care which circumstances permit. This result is not a sure guide as to all diseases, for which diarrhœa and similar disorders contribute a notable proportion to urban mortality in general; deaths from diphtheria and whooping-cough in the Rhine provinces are more numerous in the country than in the towns. Professor Finkelnburg also notices that the mortality in cities increases in the summer and fall, while the increase in the country takes place during the winter and spring.

Indians of the Hudson Bay Territory.—Dr. John Rae has furnished the Society of Arts with some information about the native tribes of the Hudson Bay Company's Territories, which is all the more valuable because it is thirty years or more old; for it brings us nearer to the original condition of the tribes before they were affected as much as they are now by intercourse with the white men. Dr. Rae divides the native tribes of the Territory into the Innuits, or Esquimaux, of the Arctic seaboard down to Labrador; the Dené Dindjié, eleven tribes east of the Rocky Mountains and south of the Esquimaux; the Algonquins, twelve tribes; and the Hurons-Iroquois, of Lake Huron, the Ottawa River, and the Province of Quebec. The Wood Crees, one of the principal tribes on Hudson Bay, are a fine, docile race, with comparatively few faults, and these injurious only to themselves. They are very fond of strong drinks, and have a great dislike to agricultural labor on their own account, although they work very well for others when paid for it. They make their living by hunting wild fowl and animals, of which the most valuable to them appears to be the rabbit. Their clothing was chiefly made of rabbit and reindeer-skins before they came in contact with the white men. Rabbit-skins sewed together make the warmest of blankets, even though the fingers may be pushed through them anywhere, and an Indian child dressed up in them, like "baby bunting," is a funny-looking but very cozy creature. The Indian babies seem never to cry, never to squall, as more civilized babies are in the habit of doing, and are never chastised. "It would be thought very unnatural and cruel in a mother to flog or strike her child." All the Indians treat with much ceremony and respect the body of any bear they may have killed. He is placed in a sitting posture against a tree, and long speeches are made of apology and regret for having been under the disagreeable necessity of killing him. Then, as the bear may come to life again even after he has been disemboweled, a stick is put into his mouth to keep it wide open, and a profuse and humble apology is made to him for the additional indignity. The supposed necessity for this precaution is believed to have arisen from the fact that a bear, thought to be dead, came to life again while being carried home, and took a mouthful out of one of his Indian bearers. With a small tribe called the Dog-ribs, or slaves, the custom prevails of wrestling for the right to a wife, "the lady sitting by, an apparently careless and indifferent spectator of the struggle for possession. No other ceremony is required than that the victor, whether her former husband or not, claims his wife." Another custom, and an unfortunate one, is that on the death of a near relative these Indians must destroy every article of property of value that they possess, excepting perhaps an old deer-skin robe and a few other articles. They, moreover, can not hunt during the season in which the loss occurs, and are thus exposed to great poverty. With nearly all the Indians, a certain favorite piece of deer or bird is tabooed to the women, and they dare not taste it, or even come near where it is cooking, under a severe penalty. With the Chippewas it is the moose-nose, with the Wood Crees some part of the wild-goose, and with the Dog-ribs the reindeer head. A peculiarity of the Hudson Bay Company's tariff, which has been considerably misrepresented, is that far higher prices, in proportion to their value, are paid to the Indians for inferior furs than for the finer ones. The object of this regulation is simply to prevent the undue hunting of the more expensive furs. "I fear," says Dr. Rae, "that little can be done for these northern Indians, unless they can be reasoned out of their prejudices and superstitions, which, with their imprudences and wastefulness, are the cause of their being so poor."

Ass's Milk for Infants.—M. Parrot, physician at the Hospital for Assisted Children in Paris, has recently made a report of the success which has attended the efforts he has made to introduce an improved system of alimentation into the nursery of that institution. His conclusions, confirmed as they are by the observations of his colleague, M. Tarnier, who had the charge of an important class of young nurses, deserve the particular attention of hospital and municipal administrations. Good nurses are very scarce, and it is hard to keep a strict watch upon the children consigned by the public charities to their care. On the other hand, a goodly number of these poor little ones come into the world afflicted with diseases which forbid their being committed to a nurse, because they would be in danger of infecting her. At the Children's Hospital, where the proportion of these wretched infants is always considerable, it has been found necessary to feed them from the bottle in the halls of the infirmary. Notwithstanding the most intelligent care, this means has not been efficient to restore the strength of the infants, who were, in fact, nearly moribund with disease contracted in their mother's womb. M. Parrot had a single chance to save them and tried it; it was to nurse them directly at the teat of an animal. The nursery which has been established in the gardens of the Hospital for Assisted Children has been in operation for about a year, and the results of the experiments have been so satisfactory that no reason exists for waiting for a longer trial before making them known. In the face



Ass's Milk Nursery at the Hospital for Assisted Children, Paris.

of the preliminary difficulties in personal instruction and the insufficient number of animals at the disposal of the hospital, the rate of mortality has been greatly reduced. The infants were at first fed with goat's milk, but it was soon found that ass's milk was better for them; and they are now all fed with milk which they draw directly from the teat of the animal. One, two, and sometimes three children are presented to the ass at the same time, being held at the teat in the arms of the nurse, and the operation is performed with wonderful ease. Numbers speak most eloquently of the success of the method. During six months, eighty-six children afflicted with congenital and contagious diseases were fed at the nursery. The first six were fed, by stress of particular circumstances, with cow's milk from the bottle; only one of them recovered. Forty-two were nursed at the teat of the goat; eight recovered, thirty-four died. Thirty-eight were nursed at the teat of the ass; twenty-eight recovered, ten died. In the face of such results there can be hardly any hesitation in declaring that in hospitals, at least, the best method of feeding new-born children, who can not, for any reason, be confided to a nurse, is to put them to suck directly from the teat of an ass. The virtues of ass's milk have not waited for recognition till this late day. Paris and other large cities have, for many years, enjoyed the visits of troops of asses which have been brought in to supply the restorative liquid to the sick and feeble. If we may credit the legend, the use of this milk was introduced into France during the reign of Francis I. That brave monarch had fallen into a state of extreme exhaustion, in consequence of his over-exertion in military and other exercises. His physicians not being able to produce any change in his condition, a Jew was brought from Constantinople, who prescribed simply a beverage of ass's milk; he took it, according to the chronicle, and became better. Ass's milk owes the advantages which it possesses over that of goats to its chemical composition, the distinguishing feature of which is that it contains less plastic substance and butter than goat's milk. Like mother's milk, it forms a precipitate of little isolated flakes easily soluble in an excess of gastric juice. It does not load the stomach of the sickly and puny infants, who ought to be spared all possible difficulty in digestion. Mare's milk would be, if it were easy to get, a still better substitute for mother's milk. It has nearly the same composition, and M. Berling, a Russian physician who has tried it, has found in it all the qualities necessary to sustain new-born children.

Aborigines of the Isthmus.—Mr. E. G. Barney has given in the "American Antiquarian" an account of the history and present condition of the native races of the United States of Colombia. The territory of that republic, now divided into nine States and six Territories, was inhabited at the time of the discovery and conquest, from 1498 to 1545, by a dense population, which was variously estimated at from eight million to twenty million souls. The inhabitants of the State of Panama were in various stages of advancement, "from dwellers in the tree-tops to a degree of civilization very much superior to that of Britain at the time of the Roman conquest, or indeed at the time the Saxons ruled the island." Columbus in one of his letters speaks of his brother having seen a house devoted to the dead, and containing many well-embalmed bodies, over which were wooden slabs engraved with the figures of various animals, and one bearing a good portrait of the deceased. During a journey in the interior, this brother found a dense population, entirely agricultural, and passed at one place eighteen miles through continued fields of corn. The inhabitants of the coasts and islands wore little clothing, but valuable ornaments of gold, and these appear to have been imported from other states, being bought for gold-dust, dried fish, and products of the soil. Balboa and his forces were entertained in the spacious house of a cacique, in one of the rooms of which were kept the embalmed ancestors of the chief for many generations, and which was surrounded by large grounds with towering palm-trees and gardens and orchards. These people, who appear to have compared favorably with most European nations before the invention of gunpowder, are believed to have been of the same race with the North American Indians, but agricultural in their habits. Their weapons of war were bows and arrows, darts, lances, war-clubs, etc. Their implements of husbandry were stone axes and sharpened sticks hardened in the fire, and their mills were smooth stones, rubbed together with the hand. Their nets for fishing were made of the fibers of the *Agave Americana*, and their hooks were made from turtle-shells. On the head-waters of some of the tributaries of the Atrato "were found one tribe of very skillful artisans in golden ornaments; another equally skillful in spinning and weaving cotton cloths, nets, hammocks, etc., the former being very tastefully colored; and another tribe adjacent were agriculturists, but showed unusual taste in adorning the surroundings of their homes with gardens, fruit-orchards, etc. One tomb is mentioned as having been artistically constructed, from which the sum of forty thousand dollars was taken by César and his party. . . . These tribes are said to have had *adoratorios*, and a system of religious belief too variously stated to enable me to form any opinion of its character." In the upper valley of the Cauca, on the slopes and valleys of two immense mountain-ranges, dwelt many tribes, either wholly agriculturists or partly agriculturists and partly fishermen, or manufacturers of salt, golden ornaments, or cotton cloth, etc. Many of the tribes in this valley were considerably advanced in culture; some had the streets of their towns wide and regular; some were manufacturers of cotton goods; one manufactured golden ornaments, and two made salt by boiling down saline waters. It cost much Castilian blood to subdue these people, but, finding that they could not contend against the superior weapons of the Europeans, they generally refused to plant, and in two years the Spaniards were compelled to begin to introduce negroes to till the ground so lately occupied by a happy and contented people. "Along the eastern side of the Gulf of Darien and along the northern slopes of the Abibe, the descendants of the independent tribes, whose poisoned arrows defeated nearly every attempt to penetrate their country, still hold their native land as free from the intruder as when the European invader first attempted its conquest. . . . An infinity" of mounds was found in one locality, and twenty-four human figures in wood in one of the temples, and golden bells outside, "which gave out sweet chimes in ever-varying tones." Some of the mounds contained ornaments, in imitation of every form of life, from the ant to a human being, and of every value from $10 to $30,000.

Waste of the World's Forests.—When the forests of such a country as Cyprus were destroyed, said Mr. Thistelton Dyer in a discussion in the British Society of Arts, it was like a burned cinder. Many of the West Indian Islands are in much the same condition, and the rate with which the destruction takes place when once commenced is almost incredible. In the Island of Mauritius, in 1835, about three fourths of the soil was in the condition of primeval forest, viz., 300,000 acres; in 1879, the acreage of woods was reduced to 70,000; and in the next year, when an exact survey was made by an Indian forest officer, he stated that the only forest worth speaking about was 35,000 acres. Sir William Gregory says that in Ceylon, the eye, looking from the top of a mountain in the center of the island, ranged in every direction over an unbroken extent of forest. Six years later the whole forest had disappeared. The denudation of the forests is accompanied by a deterioration in the soil; and the Rev. R. Abbay, who went to Ceylon on the eclipse expedition, calculated, from the percentage of solid matter in a stream, that one third of an inch per annum was being washed away from the cultivated surface of the island. In some colonies the timber was being destroyed at such a rate as would soon lead to economic difficulties. In Jamaica, nearly all the timber required for building purposes has already to be imported. In New Brunswick, the hemlock-spruce is rapidly disappearing, one manufacturer in Boiestown using the bark of one hundred thousand trees every year for tanning. In Demerara, one of the most important and valuable trees, the greenheart, is in a fair way of being exterminated. They actually cut down small saplings to make rollers on which to roll the large trunks. In New Zealand, Captain Walker says he fears that the present generation will see the extermination of the Kauri pine, one of the most important trees. All these facts show that this is a most urgent question, which at no distant date will have to be vigorously dealt with.

Professor Huggins on Comets.—Professor Huggins endeavored, in a recent lecture on comets, to distinguish as clearly as possible between what we know about those bodies, and what is only speculation. Some comets have become permanent members of our system, while others probably visit us once only, never to return. It depends upon a comet's velocity whether its orbit shall take the shape of a returning curve or not. If the velocity, at the earth's distance from the sun, exceeds twenty-six miles a second, the comet will go off into space, never to come back to us. The small portion of the comet's life during which we are able to study it—when it is in a condition of extreme excitement, in consequence of its nearness to the sun—is quite unlike its ordinary humdrum existence, when it has only a nucleus and no tail. Spectroscopic observations of comets show that they shine with an original light, the bands of which indicate a composition of carbon combined with hydrogen, and also with a reflected light, the lines of which indicate the presence of a nitrogen compound of carbon. Moreover, "certain minor modifications of the common type of spectrum are often present, and show, as was to be expected, that the conditions prevailing in different comets, and, indeed, in any one comet from day to day, are not rigidly uniform." The study of meteorites, Mr. Huggins suggests, may throw some light on the constitution of the nuclei of comets, which are probably similar to them, and therefore solid. The tails have been supposed to be gaseous matter sent off by the sun's repulsive action. The gases are probably not products of decomposition, but matter that has been occluded. Experiments so far throw little light on the question whether cyanogen is present in combination or otherwise within the comet, or whether it is found at the time by the interaction of carbonaceous and nitrogenous matter. In the latter case we should have to admit a high temperature, which would be in favor of the view of an electric origin of the comet's light. The curved forms of the tails of comets, and their greater density on the convex side, admit of explanation on the supposition that they are matter repelled from the sun. On this hypothesis, also, a comet would suffer, of course, a large waste of material at each return to perihelion, since the nucleus would be unable to gather up again to itself the scattered matter of the tail; and this view is in accordance with the fact that no comet of short period has a tail of any considerable magnitude. There seems to be a rapidly growing feeling among physicists that both the self-light of comets and the phenomena of their tails belong to the order of electrical manifestations.

The Sunken Southern Continent again.—The French Academy of Sciences recently had before it the question of the former existence of the hypothetical Southern Continent. M. Émile Blanchard presented the condition of living faunas and floras as affording evidence of the former existence of such a continent. Additional proof was suggested by the examination of the charts of the sea-depths, which show that the whole region where the lands that may be regarded as the remains of a continent are located is one of comparatively shallow water; beyond this space, the seas are very deep. The large accumulations of remains of moas that are observed in small districts indicate that an enormous number of those gigantic birds must have existed in New Zealand at no very remote period. It is hard to believe that their extinction can have been brought about by the Maories, never very numerous. Physical events must probably have been the primary cause of their destruction. While they were scattered over an extensive territory, their existence was easy; as the land sunk from under them, they had to take refuge in the spaces that remained above water. Under the new conditions the moas would have perished by hundreds wherever they became crowded together in too great numbers. Thus the extinction of these birds lends further probability to the hypothesis of the sinking of a southern continent. We are still without sufficient information respecting the floras, especially do we lack precise knowledge of the entomological fauna of the little islands which are suspected of being the remains of a continent. M. Alphonse Milne-Edwards remarked that it seemed hard to believe that the Mascarene Islands, small as they are, and apparently so little favorable to the vigor of their respective faunas, can each have been the cradle of species so well characterized and so different from those that exist elsewhere. More probably each of the volcanic cones constituting the nucleus of those islands existed before the lands were sunk to a considerable extent, and served as the last refuge for the now extinct zoölogical population of the neighboring region. This fauna has such points of resemblance with those of New Zealand and other parts of the Antarctic region, that we can not hesitate to class it with the Austral faunas. It may, thus, possibly have extended farther south. We are thus brought to the idea of a great land formerly existing in the part of the Atlantic Ocean now occupied by the immense masses of marine plants commonly known as kelp. The absence of mammalia from any region does not particularly indicate that the land was unfitted for them, but that it was separated from the rest of the globe before mammalia appeared.

The Decline of Life-Insurance.—The English life-insurance agents are remarking upon the fact that a pause has come in the expansion of their business. This may be partly owing to a change in the general disposition to insure, in consequence of the growth of the idea that the same end may be reached by saving; partly by the increasing age at which the insuring classes marry; and partly by the vigorous and successful competition of American offices, which seem to be offering better security and better terms. The "Spectator" thinks that these causes are relatively insignificant, and that the main reason for the decline of insurance "is a desire on the part of the public for less trouble, more security, and better terms." It suggests that the companies regard themselves too much in the light of benefactors of the human species, and not as much as they ought in the light of tradesmen anxious for custom. "At present the insurer is treated as a swindler, to be guarded against, and cross-questioned, and watched; and, as he seldom insures in complete free-will, but is compelled by his relatives, or his wife's relatives, or his creditors, he is unusually and unduly affected by his treatment." The minuteness of the medical inquiry required as a preliminary to insurance operates as a deterrent. The candidate does not like to have symptoms discovered by an over-zealous examiner which are invisible to laymen, and even to himself; "to have all his weak places found out; to stand a cross-examination from a man he did not select, and regards, for the moment, as an enemy, as to his habits of life; or to run the risk of the shock involved in a rejection, for reasons left unexplained." Insurance is a business in which a much slighter annoyance than this will turn a waverer, and induce him to resolve that he will save his money to himself. The value of the inquiry is, moreover, vastly overrated. The physician may be able to decide upon the candidate's bodily condition at the moment, but he can not decide what it will be three months hence, nor estimate "that quality of vitality which, and not health, is the question for the insurance-office." Persons who seem almost at the point of death frequently live for years; while those who appear most vigorous are as subject as any to quick death from fever. Persons also hesitate to insure because they can never understand the financial condition of the company, or satisfy themselves that they can get back the money they pay in premiums. More clear statements of accounts would commend the offices to a degree of confidence they do not now enjoy; and a provision by which the loss of premiums already paid in, in case of default, would be obviated, would go far toward strengthening the courage of the weak, and toward meeting the secret apprehension of the intending insurer that he might not be able to keep up his insurance.

Coeval Grades of Civilization.—A writer in "Blackwood's Magazine" has found, in the Island of Coll, of the Hebrides, evidence of the co-existence of widely removed degrees of civilization at an extremely remote antiquity. The storm of December, 1879, which caused the destruction of the Tay Bridge, also effected the removal of a few inches of sand from the bottom of a deep sand-valley near the castle, and exposed a number of old dwellings and human remains. Among the remains were kitchen-middens like those of Denmark, composed of littoral shells; bones and teeth of wild and domestic animals, split up for the sake of their marrow; chips of flint, all unpolished or palæolithic; and many fragments of rude, unglazed pottery. Along with these, in one of the heaps, were two curious bronze implements or ornaments, one of them a rich penannular brooch, of considerable beauty and finish, jeweled in twelve holes, and bearing distinct traces of having been gilt. The other ornament was a bronze pin, which had apparently been molded. Here, then, "at the most remote point of the prehistoric life of Coll to which we can reach, we find man, if a savage, still a person of taste, who could appreciate high art, and knew how to supply the wants of the dandy." These people carried on a commerce, for they had flints, which are not found in Coll, or anywhere near it, and were acquainted with the art of sailing, for their flints must have been brought from the south of England. The antiquity of the remains is estimated from their geological situation. They lie in the bottom of a shifting-sand valley, with large masses of sand around them, in a situation where no man would have ventured to settle if the sand had then been in the neighborhood to anything like the extent it is now. The sand is the result of the disintegration of the shells of snails which live on the island, and must, the most of it, have accumulated since the village was occupied. A palæolithic age and a considerable degree of civilization were coeval then in the Hebrides, and they are coeval there now. At Tiree, which is separated from Coll by a channel only two miles wide, *craggans* and other articles of pottery, exactly similar to these palæolithic ones of Coll, are manufactured and used at this day. "The old woman of Tiree, in this very year, takes the brown, stiff clay at her cabin-door, picks the pebbles out of it, pounds it down and softens it with a rude wooden mallet, molds it into shape with her rough, horny hands, and, without the aid of a potter's wheel, ornaments it, after a time-honored fashion, with a little stick or her thumb-nails; places the rude vessel thus formed — a kind of bowl or cup — in the strong heat of the sun, or before the blaze of the peat-fire, and so produces a rough, unglazed *craggan*, out of which she drinks her milk, and in which she infuses her tea. And all the while—let it be noted with all the emphasis at our command—several of her neighbors, with whom she is in daily intercourse, and with whom her teacher has been in daily intercourse, possess and use some of the finest ware that Leek or Burslem can produce. All round here, even in Tiree, are products of advanced art; but this native artist goes on her way unheeding all change and all advance, and turning out her unglazed ware as her ancestors had done—though probably in a superior style of art and workmanship—for perhaps thousands of years." Another fact to be noticed about these prehistoric remains is "that, of existing 'Celtic' brooches and penannular rings exhumed from great depths, the most highly finished, both in form and ornamentation, design and workmanship, are certainly the oldest," all showing that there has "at least been a relapse in a particular art."

Birds in Cold Weather.—M. F. Lescuyer has published some interesting observations concerning the power that was shown by the birds of his district of the valley of the Marne, France, for resisting the severe cold of the winter of 1879–'80. The sparrows, finding shelter and food around the houses, passed the season fairly well, but some of them perished in the roads and gardens; they became more scarce toward the end of the winter, and lost all their liveliness. The partridges gave way under sixty-one days of cold and hunger, and those that survived fell an easy prey to the hawks. A private watchman caught more than thirty with his hands, warmed them up, and let them loose again. The owls in the lofts and steeples could not resist the cold, and fell dead to the ground, or took refuge in the houses, where they were captured. The stomachs of all these birds were empty or nearly empty. The crows, which range over a larger extent of land than the former birds, which may be called sedentary birds, came nearer to the houses when the cold was at its worst, and considerable numbers of them were seen during the whole winter in the barn-yards and fields. Some of them came into the court-yards to eat with the pigeons, but many were frozen to death on the limbs where they roosted. The few birds of passage that staid in the country to winter showed very unequal powers of resistance. The bullfinches and grossbeaks did not seem to suffer, but the larks, yellow-hammers, greenfinches, robin-redbreasts, magpies, blackbirds, and jays were decimated. Never were so few birds seen in the woods at that season as in the following spring. Birds of passage, coming from the north to seek a milder climate in France, were disappointed. Domestic birds would have suffered greatly but for the shelter and feeding they enjoyed; fowls were worse affected than web-footed birds. The winter to which these observations relate was one of the severest ever experienced in France, and was very much like one of our Northern winters.

NOTES.

Dr. D. E. Salmon has pursued parallel investigations with those of M. Pasteur, of the microbe of hen cholera, and has conclusively satisfied himself of the accuracy of the results announced by the latter. He regards his researches as demonstrating that the virulent liquids of the fowl's body contain micrococci, that these can be cultivated, and that liquids in which bacteria are cultivated produce the disease by inoculation. His experiments indicate that the activity of the virus is destroyed at a temperature of 182° Fahr.

George H. K. Thwaites, Director of the Royal Botanic Garden at Peradeniga, Ceylon, died September 11th. He was appointed to the position in 1849, and in connection with it published in 1858–'64 an enumeration of the plants of Ceylon ("*Enumeratio plantarum Zeylaniæ*"). He was active in introducing to the island the cultivation of cinchona, tea, cocoa, Liberian coffee, and the India-rubber tree.

According to Mr. G. Macloskie, the elm-leaf beetle hibernates in cellars and attics in countless numbers. Three broods are brought forth in a season. This destructive insect is found only in the Eastern States and parts of New Jersey and Pennsylvania. Poison is the most complete remedy for it —one pound of London purple to one hundred gallons of water, squirted up into the tree.

Louis Palmieri, Professor of Physics in the University of Naples and Director of the Seismological Observatory on Mount Vesuvius, has recently died, at the age of seventy-five years. He was appointed to the two posts in connection with which he has gained scientific renown in 1854, and has since pursued the study of earthquakes and the phenomena associated with them, with a real devotion. He was the inventor of an electro-magnetic seismograph, by which the most delicate indications of subterranean action could be detected.

M. Potel has recently submitted to the French Society of Encouragement a new substance, which he has named, after himself, "poteline," and which appears to be susceptible of numerous applications. It is a mixture of gelatine, glycerine, and tannin, and is, according to the inventor, absolutely impermeable to the air. When warmed, it becomes liquid, or nearly so, and takes all the contours of an object. M. Potel has made corks of it, which form an economical substitute for metallic capsules, and secure an hermetic closing. He has used it as a coating to preserve meat. At a temperature of 112°, it envelops the meat, kills the germs of putrefaction, and prevents any new germ passing in. According to M. Potel, meat thus treated will retain all its freshness for two months.

According to the experiments of M. Demarçay, the metals which are generally regarded as fixed, even iron, give out real vapors at relatively low temperatures. Cadmium, for example, volatilizes at 257° and zinc at 302°. Magnesia had already been found to be volatile below a red heat, when acted upon by water and chloride of silicon.

With the aid of M. Lippman's electrometer, M. Trousseau has succeeded in measuring the electrical conductibility of the poorer conductors, particularly of glass. Common glass is very perceptibly conductive, Bohemian glass is less so, while cut-glass has no sensible conducting powers. M. Dumas regards this classification as repeating from the electrical point of view the one which he has established as dependent on the presence of alkaline salts in the vitreous mass; of which cut-glass has none, Bohemian glass very little, and common glass a considerable quantity.

Admiral Count Feodor Petrovitch Lütke, founder of the Russian Geographical Society and President of the St. Petersburg Academy of Sciences, died in August last. His name is identified to a considerable extent with the history of Russian polar and exploring expeditions, and with the discovery of some island groups in the Pacific. He had published narratives of his Arctic expeditions and of a voyage round the world.

The fact that an aniline black can be formed with vanadium has provoked investigation into the feasibility of the production of that metal for commerce. MM. Osmond and G. Witz have found a considerable source of supply in the foundry-scorias of Creuzot, France, which contain two per cent of vanadic acid. The scorias have only to be treated with hydrochloric acid to obtain from them a green liquor which can be used directly in dyeing.

It has been urged against the theoretical importance of the agency of insects in fertilizing flowers, that the insects relied upon are rare upon mountain-heights, where the flowers that should be fertilized by them are still abundant. The observations of M. Ch. Musset, of Grenoble, France, which range up to 10,000 feet in height, tend greatly to break the force of this objection. He finds that all the orders of insects are represented to the height of 7,400 feet, and that the number of nectar-seeking insects is proportionate to the number of flowers. The hours of wakefulness and of sleep of the nyctitropic flowers—the number of which is greater than is supposed—and those of the insects are synchronous. The apparent number of nectar-seeking insects, also, is related to the number of their favorite flowers.

Johannes Theodor Reinhart, Professor of Zoölogy at the University of Copenhagen, and Inspector of the Natural History Museum of that city, died October 23d, aged sixty-six. He was eminent in ornithology, and was author of a memoir on the birds of the Campos of Brazil, and of numerous papers in the scientific periodicals of Copenhagen.

M. Bergeron has produced imitations of the forms of lunar craters, by turning a current of gas into a melted metallic mass at the moment when solidification is about to begin. He obtained exact representations of the different varieties of hollows shown upon the moon by using different metallic mixtures.

Professor Sollas, of Bristol, has proposed to the British Association a scheme for securing a complete record of published scientific work, the essential feature of which is, that each nation furnish a record of its own work and of that only, and exchange with all other nations for their records. National committees are to attend to the preparation of the records, the transmission of exchanges, the translating and the composition of the records into a single work, and an International Congress is to take care of the uniformity and the successful working out of the scheme.

The death is announced, at forty-three years of age, of M. Georges Leclanché, the inventor of the oxide of manganese constant elements.

HENRI MILNE-EDWARDS.

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THE AFRICAN IN THE UNITED STATES.

By Professor E. W. GILLIAM.

THE future of the African in the United States is, in the judgment of many, the gravest question of the day. It must, from its nature, swell in volume and thrust itself forward more and more; and though the evils as depicted in these pages be in their worst forms comparatively remote, yet, if there be real grounds for them, the time for action in seeking and applying a remedy lies in the present. The far-reaching and critical character of the subject demands that it should be approached without political bias, and treated solely from the point of view of the national welfare.

In this spirit the reader is referred to the tabulated figures on a succeeding page, derived from an analysis of the census of the United States, and of several of the Southern States, for each decade from 1830 to 1880 inclusive, and showing the rate per cent of increase or decrease of the white and the black population for the basis of the following discussion.

The very high rate of increase for the whites in the United States, in the first, second, and third decades, is due to a copious immigration adding itself to a lesser population. As the population of a country swells, and the immigration remains about the same, the rate per cent of increase falls.

The enormous rate of increase in several of the States, in the early decades, notably Arkansas and Mississippi, is altogether abnormal, and readily accounted for. These were then new regions, just opening to settlers, and the older slave States poured into their rich bosoms an overwhelming tide. Multitudes of whites, with and without slaves, like bees from a hive, swarmed forth from the older States, to settle in these cheap and productive parts. Hence it is that South Carolina, for an example, shows, from 1830 to 1840, an increase of only one half per cent for the whites, and three per cent for the blacks, while for Arkansas the corresponding figures are two hundred and six per cent, and three hundred and thirty-two per cent. Only when States have been fairly settled, and peculiar causes affecting population removed, does an enumeration reveal the natural increase of a people; and this, as a wide and accurate observation in the United States has shown, can not be, under the most favorable circumstances, above thirty-five per cent—at least for the white race.

Thoughtful minds awaited with special interest the results of the census for 1880. It closed the first decade of freedom for the blacks; and whether this race, under its new conditions, was an increasing or decreasing one—whether it was increasing more rapidly than the whites, or otherwise—these were questions of critical and far-reaching importance.

It is seen that over the United States the gain for the whites has been twenty-nine per cent, that for the blacks thirty-four per cent, and that the latter is by much the highest figure reached by the blacks in the several decades. Referring to the figures of the last decade, belonging to the States, it is further seen that, while the gain in all these States, both for white and black, is remarkably high, the gain in several instances—as in the case of Arkansas, South Carolina, and Mississippi (for the blacks)—is too high to be credible, transcending as it does the natural procreative power of the most prolific race. (The reader will remember that from 1870 to 1880 the population of these States received little or no accession from immigration.) The gain in population, immediately succeeding a continued and desolating war, must be more or less abnormally large. It is readily accounted for by the separation of husbands and wives, the procrastination of marriage on the part of the young, and the prevailing destitution, at least comparative destitution, accompanying a state of war. But, with every allowance on these grounds, the rate of increase in the States just mentioned remains incredible, and either the census for 1870, or that for 1880, must be in error.

The error is doubtless in the former. The census for 1870 was made under the old law of 1850, a law which those well qualified to judge deem, in some important particulars, grossly defective. Again, the enumerators were, for the most part, negroes, often ignorant and inefficient; and it is on evidence that the enumeration of counties (at least as regards South Carolina) was not unfrequently made at court sessions and on muster-grounds, and not by a house-to-house canvass. The exceedingly high rate of increase in South Carolina as a State, and particularly in certain districts thereof, induced the Census Superintendent for 1880 to send thither a special agent, for the purpose of ascertaining the facts. Not all the State was canvassed, but enough to substantially verify the census for 1880; and this, with the further consideration that the census for 1880 was made under a new and improved law, and by enumerators who, as a body, were thoroughly qualified, ought to be considered as settling the matter, and placing the error at the door of the preceding census. It is to be observed, in passing, that if the error, as practically it does, bears equally against white and black alike, however the figures for the two races, taken absolutely, may vary from the truth, yet are they still a proximate guide, considered relatively, to the comparative rate of increase of the races.

(1.) UNITED STATES.

	White.	Black.
1830 to 1840	34 per cent.	23 per cent.
1840 to 1850	38 "	23 "
1850 to 1860	38 "	22 "
1860 to 1870	24 "	9 "
1870 to 1880	29 "	34 "

(2.) ALABAMA.

	White.	Black.
1830 to 1840	76 per cent.	114 per cent.
1840 to 1850	21 "	35 "
1850 to 1860	21 "	27 "
1860 to 1870	1 " loss.	8 "
1870 to 1880	27 "	26 "

(3.) ARKANSAS.

	White.	Black.
1830 to 1840	206 per cent.	332 per cent.
1840 to 1850	111 "	133 "
1850 to 1860	98 "	133 "
1860 to 1870	11 "	9 "
1870 to 1880	63 "	72 "

(4.) SOUTH CAROLINA.

	White.	Black.
1830 to 1840	½ per cent.	3 per cent.
1840 to 1850	6 "	17 "
1850 to 1860	6 "	5 "
1860 to 1870	½ " loss.	1 " loss
1870 to 1880	35 "	45 "

(5.) NORTH CAROLINA.

	White.	Black.
1830 to 1840	2 per cent.	1 per cent.
1840 to 1850	14 "	17 "
1850 to 1860	14 "	14 "
1860 to 1870	7 "	8 "
1870 to 1880	28 "	36 "

(6.) MISSISSIPPI.

	White.	Black.
1830 to 1840	155 per cent.	197 per cent.
1840 to 1850	64 "	57 "
1850 to 1860	19 "	40 "
1860 to 1870	8 "	1½ "
1870 to 1880	25 "	47 "

(7.) LOUISIANA.

	White.	Black.
1830 to 1840	77 per cent.	53 per cent.
1840 to 1850	61 "	35 "
1850 to 1860	39 "	33 "
1860 to 1870	1 "	4 "
1870 to 1880	25 "	33 "

(8.) GEORGIA.

	White.	Black.
1830 to 1840	37 per cent.	28 per cent.
1840 to 1850	27 "	35 "
1850 to 1860	13 "	20 "
1860 to 1870	8 "	17 "
1870 to 1880	27 "	32 "

It is estimated that five per cent from the rate of gain for the entire Southern blacks, as by census for 1880, is a fair allowance for this error, making their real gain about thirty per cent. Yet, as an obvious consideration points to the conclusion that the blacks will for the future develop in the South under conditions more and more favorable, it is not unreasonable to think that, in subsequent decades, this five per cent will be regained.

That consideration is the more complete adjustment of the black man to his new surroundings. His comparative helplessness immediately after emancipation was a condition adverse to his increase. The absence of thrift, energy, and management, many think, marks negro character at its best. It is certain that the contraries to these qualities had, under a long condition of servitude, been abnormally developed. Emancipation found the negro without the master's care (and, as a body, slaveholders, at least from motives of self-interest, were humane), without the customary oversight and medical attention, dependent, not self-reliant. No wonder that many of the negroes have been worse off than under their former bondage; that the burden of life has been so often excessive; that infanticide has been so often resorted to, to lessen it; and that death from want and exposure has been so exceptionally frequent. A body of four million slaves, ignorant, uncivilized, and trained in habits of dependence, suddenly set free, then invested with the ballot, and intoxicated with political power, then checked, and in many instances violently checked, by the necessary and wholesome self-assertion of the white race, that they should have increased as they have done is astonishing, and can be accounted for only by the remarkable fecundity of the African. For the future the adverse influence to population, arising from this cause, will become less and less potent. The negro, adjusted to his surroundings, will work with more ease and effect. He is ascending from the lowest round. Education must give him increased power to accumulate, experience must improve his thrift, and, life passing under better conditions, it is reasonable to think that in subsequent decades he will add five per cent of increase to that of the past. We put this rate at thirty-five per cent.

The gain for the whites in the last decade is very nearly thirty per cent. This is to be docked in the Southern States to the extent of five per cent for the error in the census of 1870. Since, however, this error appertains only to the twelve million Southern whites, and the census in regard to the thirty million Northern whites is accepted as correct, the rate of increase for the total white population is a fraction under twenty-nine per cent. Of this at least nine per cent should be attributed to immigration. Immigration is now, and for a year or two past has been, largely in excess of this figure, but probably not for the past decade; and the resultant is a gain of twenty per cent for the entire native white population.

There is a wide, and, at first view, startling difference between the twenty per cent for the whites and the thirty-five per cent for the blacks. The solution is found in the superior fecundity of the latter. This superiority, while it belongs to the blacks as a race, is strengthened for them—1. As being the laboring class; 2. As laboring under favorable climatic conditions; that is to say, living in a semi-tropical region.

The laboring class is naturally the more fruitful class. In the case of a laboring woman the child-bearing period is greater by a number of years than in one more delicately reared. Again, in estimating fecundity, the pain and danger attendant upon parturition are factors, and its comparative ease to the laboring woman, contrasted with the profound and long-continued prostration it brings to the lady of tender palms and jeweled fingers, is well known.

Again, the African on climatic grounds finds in the Southern country a more congenial home. In many districts there, and these by far the most fertile, the white man is unable to take the field and have health. It is otherwise with the African, who, the child of the sun, gathers strength and multiplies in these low, hot, feverish regions.

The wide advantage, therefore, in the rate of increase on the side of the African finds its solution in a superior natural fecundity, exerting itself under these favoring conditions.

Now mark the following: The white population, increasing at the rate of twenty per cent in ten years, or two per cent per annum, doubles itself every thirty-five years. The black, increasing at the rate of thirty-five per cent in ten years, or three and a half per cent per annum, doubles itself in twenty years. Hence we find:

Whites in United States in 1880 (in round numbers)	42,000,000
" " 1915 " "	84,000,000
" " 1950 " "	168,000,000
" " 1985 " "	336,000,000
Northern whites in 1880	30,000,000
" " 1915	60,000,000
" " 1950	120,000,000
" " 1985	240,000,000
Southern whites in 1880	12,000,000
" " 1915	24,000,000
" " 1950	48,000,000
" " 1985	96,000,000
Blacks in Southern States in 1880	6,000,000
" " " 1900	12,000,000
" " " 1920	24,000,000
" " " 1940	48,000,000
" " " 1960	96,000,000
" " " 1980	192,000,000

Our interest is in the progress of population in the Southern States, where the blacks almost altogether now are, and where they will continued to be massed more and more; and above stand the significant figures. These will be modified more or less by disturbing causes, the most prominent being immigration. But even should immigration ever take a pronounced Southern direction, yet immigration must slacken, and before many years practically cease, while the black growth must be perpetually augmenting, perpetually advancing its volume; and, every allowance being made, it is morally certain that in seventy or eighty years (as things now go) the blacks in every Southern State will overwhelmingly preponderate.

The second factor in our argument is the impossibility of fusion between whites and blacks. The latter have been, and must continue to be, a distinct and alien race. The fusion of races is the resultant from social equality and intermarriage, and the barrier to this here is insurmountable. The human species presents three grand varieties, marked off by color—white, yellow, and black. One at the first, in origin and color, the race multiplied and spread, and separate sections, settled in different latitudes, took on under climatic conditions acting with abnormal force in that early and impressionable period of the race's age—took on (we say) different hues, which, as the race grew and hardened, crystallized into permanent characteristics. Social affinity exists among the families of these three groups. The groups themselves stand rigidly apart. The Irish, German, French, etc., who come to these shores, readily intermarry among themselves and with the native population. Within a generation or two the sharpness of national feature disappears, and the issue is the American whose mixed blood is the country's foremost hope. *It can not be*—a fusion like this between whites and blacks. Account for it as we may, the antipathy is a palpable fact which no one fails to recognize—an antipathy not less strong among the Northern than among the Southern whites. However the former may, on the score of matters political, profess themselves special friends to the blacks, the question of intermarriage and social equality, when brought to practical test, they will not touch with the end of the little finger. Whether it be that the blacks, because of their former condition of servitude, are regarded as a permanently degraded class; whether it be that the whites, from their historic eminence, are possessed with a consciousness of superiority which spurns alliance—the fact that fusion is impossible no one in his senses can deny.

These, then, are the factors in our argument, and the source of the inferences to follow: 1. That the black population is gaining on the whites; 2. That the former is, and must continue to be, a distinct and alien people.

Two inferences follow—the first of a social character; the second, political:

1. The status of the black population, as a distinct and alien race, condemns the race to remain, *in perpetuum*, the laboring class. If its blood can not commingle with that of the whites, social advancement ceases at an early stage; the higher social planes are incapable of attainment; whereby is broken a fundamental social law that allows to the individual full freedom to rise or fall in the social scale, without hindrance from race prejudice or prestige.

That is the healthiest society which is the freest, which gives the fullest play to individual intelligence and energy; and in such a social state we note a tendency on the part of the rich upper class to sink, and the poor laboring class to rise; we observe therein a social cycle at whose completion the rich and the poor, the upper and the lower orders, are found, as a whole, to have changed places. It is a law of slow action, but sure.

The causes are apparent. The sons of the rich eat daintily, exercise daintily, keep late hours for resting and rising, are self-indulgent and extravagant. There are, of course, exceptions. Undoubtedly, however, the surroundings of the sons of wealth create tendencies this way, toward effeminacy of body and uneconomical habits of mind. These are downward tendencies, and, pressing through a cycle of years, bring the descendants of the rich, as a class, to the social bottom.

The poor, on the other hand, are compelled, by their condition of life, to strength-giving exercise, and careful, saving methods in the management of means. Robust bodies and thrifty ways give upward tendencies, which, acting through the social cycle, lift the descendants of these poor to the higher planes. Taking men in the mass, tendencies and results are this way.

Now, as regards the blacks, this fundamental law is broken, and the issue, in a state of society theoretically free, is approaching disorder.

The blacks are an improving race, and the throb of aspiration is quickening. Progress with the pure African is, indeed, slow. How could it be otherwise? A long dark night of barbarous ignorance in his native land, succeeded on these shores by nearly a century of servitude, wherein letters were denied him, and improvident, unthrifty habits necessarily engendered, could rapid progress for the race, under these circumstances, be rationally expected? Advancement in mental training and in economic science must needs be slow—but there *is* advancement.

That portion of the colored population known as mulattoes show, in mind and manners, a marked superiority, drawn from the side of their white parentage. This element, though increasing among themselves, is not increasing (appreciably) from admixture of bloods; because the white man can not now cohabit with negresses with the impunity belonging to days of slavery. With all its gradations it still, however, forms a very large class. They mingle freely with the pure African on terms of perfect equality, have the African instinct, and make a great factor in determining the average progress of the race.

This laboring class, working upward along the social cycle, meets, almost on the threshold of development, an impassable barrier. With growing aspirations incapable of being realized, they are doomed to remain where they have been, and be hewers of wood and drawers of water. Individuals here and there, by force of peculiar talent and fortunate circumstances, break through the opposing obstacle, and attain high positions; or such positions may be conferred in the interest of some political party. The heart knows, however, that the incumbents are recognized with an involuntary wince. They are tolerated by reason of their fewness. The mass of the blacks are held back in their state of toil. It is the mandate of American instinct.

We say *American instinct*—which is, that America is for Americans, not for German, Irish, or African, as such. The German here rises and rules, not as a German; nor the Irishman as an Irishman. When the German gets out his naturalization papers, he theoretically gets out of his German skin. Practically, he gets out of it in a generation or two, through intermarriage and association; mingles freely and equally with the mass of population; and, in the attainment of the highest social or political privilege or distinction, is limited solely by the worth of his individuality. The rise and rule of the African must be, according to American spirit, after the same method. Disappearing in the mass of population, he must lose the African cast, and transform himself, by intermarriage and social association, into an actual American; for he could be no American, however the letter of the law might read, who, after the lapse of a century, should retain the exclusive hue and affinity of a stranger race. But this transformation is impossible, seeing the blacks stand apart from the whites, and make a distinct and alien people. Any advancement of the blacks is an advancement of the African, as such; and the advancement of individuals, here and there, above the laboring level, is the vanguard of the race's advancement.

The advancement of the blacks, therefore, becomes a menace to the whites. No two free races, remaining distinctly apart, can advance side by side, without a struggle for supremacy. The thing is impossible. The world has never witnessed it, and *a priori* grounds are all against it. Hence, the whites instinctively oppose the black invasion (as it were), and seek to keep this people below the labor-line; and a large superiority, at present, in numbers, and a vastly larger superiority in intelligence and wealth, make them easily, and perhaps without conscious effort, successful.

But a fundamental social law is thus broken—a law, under whose operation, in a free social state, the poor, lower, laboring class naturally rise, while the rich upper class descend; and no law, whatever the sphere to which it belongs, can be broken with impunity. To the discontent arising from this source may be traced the periodic exodus movement among the negroes. Politicians, for party ends, have assigned other causes, and declared that "exodus" means bull-dozing, Ku-kluxing, imposition, oppression, enforced pauperism, etc. These are all wide of the mark. Since the Southern States have been under the rule of its intelligent population, the blacks, as a whole, and in the main, have been free in the exercise of political rights; and, moreover, they have prospered as never before. The underlying cause of the exodus fever, stimulated to some extent by railroad men and other side agencies, is the broken social law obstructing the upward tendency of the laboring class. Naturally they are uneasy and restless at the prospect of being held perpetually in one place, and made the bottom caste under a social status professedly free. Hence, these periodical upheavals and outflowings toward Kansas, Indiana, etc., in expectation of relief hoped for in vain; for there, too, they are no less a distinct and alien race, and the same broken social law bears its issues.

But what will the upshot be, when the black population, advancing on the white, finally outnumbers it? The outlook is most serious. It is a repetition of the Israelites in Egypt, a lower and laboring class gaining in population on the upper, and, as a distinct and alien race, causing apprehensions to the Egyptians. There is a point at which mere numbers must prevail over wealth, intelligence, and prestige combined. Unless relief comes, when that point approaches, woes await the land. This dark, swelling, muttering mass along the social horizon, gathering strength with education, and ambitious to rise, will grow increasingly restless and sullen under repression, until at length conscious, through numbers, of superior power, it will assert that power destructively, and, bursting forth like an angry, furious cloud, avenge, in tumult and disorder, the social law broken against it.

2. Treatment of the political aspect of our subject follows a similar line of thought, and must needs be brief.

We take it for a certainty that a distinct and alien race like the blacks will always, in the main, vote together. Why they all are now Republicans is readily seen. But should present political parties break up, and others be formed on new issues, the blacks would still naturally go as a body. The circumstances under which they live here, compelling them to stand together socially, will also morally compel them to stand together politically. Confined injuriously by a social barrier, they may be expected to develop abnormally the natural race-instinct, and, under a powerful *esprit de corps*, cast a solid ballot.

It is here to be said that we regard it as a mistake, both for the country and for the interests of the Republican party (and this we say with complete freedom from political bias), that the enfranchisement of the blacks followed immediately upon emancipation. The glittering sentence in the inaugural of the late lamented President Garfield, that there is no middle ground between citizenship and the ballot, will scarcely bear examination. The ballot is not a natural right, but a trust, to be granted or withheld for cause. The free blacks, in the early part of the present century, were (if we mistake not) a voting body. Experience, however, showing that the ballot in their hands became a wide-spread source of corruption, and therefore an evil, the privilege was withdrawn. It was a mistake, we conceive, to have given this privilege to a people just freed from the bonds of slavery, and still characterized, as a whole, by profound ignorance;

and, that no greater harm has resulted is, because white intelligence has been able to exert a controlling influence and shape legislation. Certainly, while the whites were disfranchised, and the blacks politically supreme, the state of the South was intolerable. Had the Republican party, devoting its entire energies to the moral and intellectual elevation of the blacks, deferred their enfranchisement to a more reasonable day, when the race, in the mass, would be less unworthy of the ballot, the power of that party throughout the South would have been otherwise than it is to-day. The issue of the war had practically settled and silenced the old Democratic State-rights doctrine. Notwithstanding the war-engendered bitterness, a large white minority, if not a majority, at the South—partly the remnants of the old-line Whigs who antagonized the political tenets connected with the war's beginning, partly converts to results which force had imposed, partly recruits from moribund Democracy—these were ready, in good faith, to accept the new order of affairs, and act with Republicanism ; and if the Republican party, rejecting the mistaken policy of seeking a foothold in the South through negro suffrage, had fostered the friendly white element, it could easily have developed this element, aided by executive patronage extending through a series of terms, into overwhelming Republican strength. Under the course pursued the almost extinct Democratic party at once revived, from a pressing sense among the whites of self-preservation. The negroes voting as a body on one side, the whites necessarily became politically massed on the other. It made little difference under what name they rallied. The term "Democrat" had been opposed to Republican in days gone by, and was now adopted. Yet thousands, banded under this party title, had no sympathy with leading and distinctive Democratic doctrines, such as those regarding the tariff, finance, or State rights. They were against negro political supremacy, as meaning disaster to the land. It had prevailed for a short period (just after the war), and left desolation in its course. The ignorance and inexperience of this unlettered mass, fresh from slavery, were immensely unequal to the science of enlightened governing. For the whites it was a matter of life or death. They became a "solid South," as any other people, similarly circumstanced, would have become. Wealth and intelligence gave them the victory, as it ever will, where numbers approach an equality—a victory that does not mean injury to the blacks, but which is the pledge for good government and order—the proof whereof is the present peaceful and prosperous condition of the Southern States, for the blacks no less than for the whites, compared with their state of wretchedness, under negro political rule, in the days following immediately upon the close of the war.

We must again ask the question, What, from this stand-point, will the upshot be when the blacks numerically will so far exceed the whites as to overcome the vantage that the superior wealth and intelligence of the latter now give them? The outlook here is no less serious. Whatever civic capability the blacks may have, it is now in germ; whatever governing aptitude the race may possess, it is at present dormant. In the history of nations it has nowhere, as yet, been exhibited. If this race in the United States is improving, its improvement, as was to have been expected, is slow; and in every political virtue it will still be vastly below the whites, when in voting strength its fecundity will have put it vastly beyond them—so far beyond as to overcome every counter-influence, and give the political reins entirely into its hands.

Who can doubt that, when this day comes, the blacks will obey a race-instinct which all their surroundings will have powerfully tended to develop, and vote blacks alone into office? Thus have they done wherever the power existed. Kept, as they are, a distinct and alien race, no other issue is reasonably conceivable. And who can doubt that, under this state of affairs—an inferior and incompetent race completely dominating, by mere numbers, a superior one—the worse disorders would ensue? The whites would not submit, and a violent and disastrous conflict of races must follow. The whites would hold (1) that, while America is a nation governed by majorities, yet by those who framed the Constitution it was never intended that a race brought here as slaves, an inferior race, one kept distinct by this very inferiority, should, merely through a superior fecundity, become politically supreme, and lord it over the land. They would hold (2) that this political lordship would be ruinous to every interest; that for a short period subsequent to the close of the war it had partially prevailed, and with the unhappiest results; and that, should this lordship become distinctively fastened upon a large section of the Union, the incompetency of the negro to provide, legislatively, for the manifold and complex interests of an advanced civilization, would arrest its activities, paralyze its trade, and spread a decline throughout the entire country.

These are real and gigantic evils gradually looming up, and they merit the immediate and best attention of American statesmen.

Colonization, we conceive, is the remedy—a scheme which the far-seeing Henry Clay so warmly advocated, though it cost him the presidency. President Mr. Clay doubtless would have been had his opponents not raised against him the cry of being an abolitionist. But he was no abolitionist. He was a colonizationist. In the negro element, even in the relatively small proportions it bore in his day, his political sagacity saw an increasing danger. It was not only that the negro, while in bondage, made a breach between the free and the slave States (whereof the civil war was the issue), but his clear-sightedness saw evil in the presence of the negro as a negro, whether bound or free. The negro, he perceived, could not unite with any branch of the whites, and in the mass of population lose race distinctiveness. He was compelled to stand off by himself, a separate and alien people. Like food incapable of digestion, and which lies in the stomach only stimulative of disease, he remained in the body politic a foreign element, without opportunity or power of assimilation, and a perpetual source of alarm. Hence, Mr. Clay advocated colonization; and happy would it have been for the country if his views had prevailed, and the slaves been bought up by the Government at an appraised rate, and transported either to their native land or to some section provided for them exclusively.

We have an impression that a move was made in Congress last winter by some Senator, looking to the acquisition of territory in Central America as a home for the blacks. Though nothing came of it, it is matter for rejoicing that Congressmen are turning their eyes this way. The sole ground whereon we favored ex-President Grant's project to buy San Domingo was that it would afford a home for our black population. Some home for them outside of this country must be provided at an early day, or ultimately their presence here will lead to complications and disorders of appalling character. The current news from the South, amid much that is cheering, strengthens our forebodings. There are a present peace and prosperity; but, to an attentive ear, mutterings of this storm are already beginning to be heard.

The republic is so rich and so prosperous, and its future, from some stand-points, so fair, that it seems invidious, perhaps, to mar the picture and reveal a frightful evil slowly developing in its bosom. Some would fain deem the danger imaginary; and, even when fully realized, the trouble, in its ultimate and worst forms, is comparatively so remote that there is a tendency to forget it, or at least to transfer its consideration to another day and generation. The remoteness of an evil, however, does not carry with it remoteness in applying the remedy. Let American statesmen of the present day be looking in the direction we have indicated. A subject so vast and so momentous it is the part of wisdom to regard before immediate threatenings *compel* consideration. Assuredly, the question will more and more thrust itself forward for solution. The black man is still the "irrepressible conflict." Great difficulties, under any circumstances, must attend its solution. Let it be solved while a peaceful adjustment is yet practicable, for there is a point beyond which the attempt to solve it would involve the rupture of the republic.

A PREHISTORIC CEMETERY.

By JOSEPH F. JAMES,
CUSTODIAN CINCINNATI SOCIETY OF NATURAL HISTORY.

ABOUT ten miles from Cincinnati, along the Little Miami River, is a locality which has long been known to the country people as the "Pottery-Field." The ground was strewed with fragments of pottery, bones, arrow-points, and other remains of like character, and the place was generally considered to be the site of an ancient workshop. The primitive forest still occupies the locality, and is made up of oak, beech, elm, maple, walnut, etc. All around are found numerous mounds or tumuli, most of them small. A few of these were opened by Mr. Florian Gianque, in 1876, and some interesting things found. But, in 1878, Dr. Charles Metz and other gentlemen interested in archæology commenced a systematic exploration of the country thereabout, and so much has been found that we are enabled to form some idea of the habits, and get a glimpse into the life, of the people who once lived in the immediate vicinity of the city of Cincinnati.

During the four years that the excavations have been carried on, between six hundred and fifty and seven hundred skeletons have been brought to light. Many of them are in an advanced state of decay, and crumble to pieces on the slightest touch, while others, again, are in a very good state of preservation. It can, therefore, hardly be inferred that, because some of the skeletons are much decayed, they are necessarily very old; for, though we have well-preserved remains of bones from Babylon, Nineveh, and Egypt, which are certainly twenty-five hundred or three thousand years old, still the cases are exceptional in which they are found in good condition after the lapse of many years. Different kinds of soil and differences in climate have much to do with the matter: for, in a dry and equable climate, bones may resist for a long time the influences which would cause their decay, while, in a moist climate, and with sudden and extreme changes of temperature, such as we have here, any bone, unless buried in peat, or subject constantly to heavy pressure, so as to become partially fossilized, is liable to soon decay.

An examination of the skulls found in the cemetery, as it is called, as well as the other parts of the skeleton shows some interesting facts. In a paper by Dr. F. W. Langdon * is given a table of measurements of the crania which shows that the brachycephalous skulls (those with an index of breadth of ·800 and over) † are largely in the majority, there being fifty-two out of seventy-two of this character. None of them, however, exhibit any signs of the flattening of the frontal

* "Journal of the Cincinnati Society of Natural History," vol. iv, pp. 237, *et seq.*

† The long diameter being taken as 100.

bone, which is such a characteristic feature of the Natchez and other Southern races of Indians. The Caribs of the West Indies and the Chinooks of Oregon both flattened the heads of their children in infancy; and the skulls of the ancient Peruvians and the figures on the monuments at Palenque show a remarkable flattening of the frontal. This is generally considered to have been the natural form of the skull, to have been the type of beauty cultivated by the Peruvians, Central Americans, Toltecs, etc., and not to have been produced altogether by compression. The peculiar form of skull became hereditary, and children were born with this (to us) deformity.

Various forms of diseased bones are found among the human remains. One of these is a peculiar anchylosis of the spinous and articular processes of some of the vertebræ, the *bodies* remaining free.* It is supposed to have been the vertebral column of a female dwarf, the skeleton of which presented several other points of interest. Among the crania are several which have been fractured by some blunt implement, and the fracture has been partially or completely healed. Two other very interesting specimens are among the human bones. One is the eleventh dorsal vertebra, in which is imbedded for a quarter of an inch one of the small flint-points called war-arrows. The other specimen is a sacrum in which there is imbedded a similar point. This last was found in a pit with twenty-two skeletons,† and doubtless belonged to an individual killed with the others in a battle, all of the killed having been buried together. These specimens show with what force the people could send their arrows. Both had entered from the front of the body, passed through it, and were only stopped by the vertebral column. Some of the long bones exhibit various excrescences which have been referred to syphilitic diseases, and which show that the people here buried were afflicted with that fearful scourge which, as some one has expressed it, "turned Europe into a charnel-house."

But the bones of an extinct race of men, interesting though they may be, can tell us but little of their domestic habits, and it is to the implements found here that we turn with greatest interest. These are so abundant, and often of such a peculiar character, that we have much to speculate upon. First of all is the remarkable circumstance of finding so many implements of bone; the abundance of which has generally been thought to be a proof of a low grade of civilization. But probably their abundance or their rarity has been regulated also by the age of the deposit, for, the older the deposit, the less likely it is that the bone relics have resisted the action of time.

Many of the remains are of a peculiar character, unlike anything found elsewhere, and speculations in regard to their origin and use are

* For a figure of this and various other diseased bones, see article in "Journal of the Cincinnati Society of Natural History," vol. iv, pp. 241–257.

† Ibid., vol. iv, p. 253.

rife. Still other relics are strikingly like some found elsewhere, not particularly in this country, but in Europe, as will be shown further on. Among the most curious and anomalous of all are certain peculiarly grooved bones, as represented in Fig. 1.* They are usually made

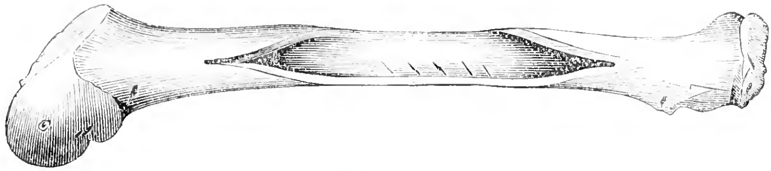

Fig. 1.

of the leg-bones of the deer or elk. But few of the specimens are perfect, the majority having been broken by use and wearing away of the bone. The groove is often highly polished, though scratches running the long way are visible. These scratches were made in the manufacture or use of the instrument or tool, but what its use was no one has been able satisfactorily to determine. Archæologists are puzzled, and pronounce them to be unique. It has been supposed by nearly every one that they were used in dressing skins, but no such scratches as are observed could be made in that operation. Some have suggested that perhaps they were made to serve some purpose of ornamentation, but neither is this explanation probable. It seems to me that the groove has been the result of rubbing, for the purpose of polishing certain other relics found here. There have been found numbers of peculiar cylindrical pieces of bone and horn, like Fig. 2, as unlike anything found elsewhere as the grooved bones; and it seems probable that these cylinders of bone have been rubbed and polished in the grooved bones. We find that the different-sized cylinders fit well into the different-sized grooves, and certainly constant rubbing would both round off and polish the cylinders, and leave scratches in the groove. It has been a matter of speculation, also, to determine the use of these cylinders. Some have said that they were used in playing a game; but it is more likely that they were made into a belt for the waist, or a necklace, thongs being woven be-

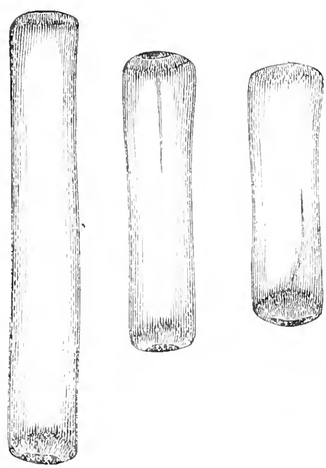

Fig. 2.

* Copied from "Journal of the Cincinnati Society of Natural History," vol. iii., plate 1. Most of the figures herein given are made from specimens in the collection of the Cincinnati Society of Natural History.

tween them, first round one, then the next, and so on. None of them show any signs or attempts at boring from end to end.*

Deer and elk horns enter largely into the manufacture of many of the relics. Among others are what are known as bone arrow or spear

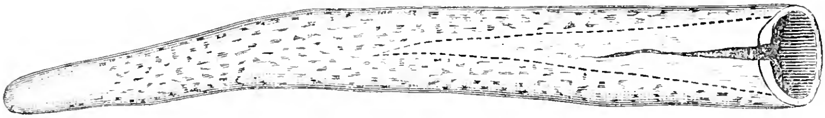

Fig. 3.

points, shown in Figs. 3 and 4. They are invariably made from the sharp points of horn, the piece being first cut off, and then a hole drilled into the blunt end with a flint. Marks made by the drill are still distinctly seen in the holes. The points were fastened to wooden shafts inserted in the holes. Now, strange though it may seem, relics

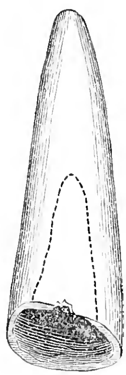

Fig. 4.

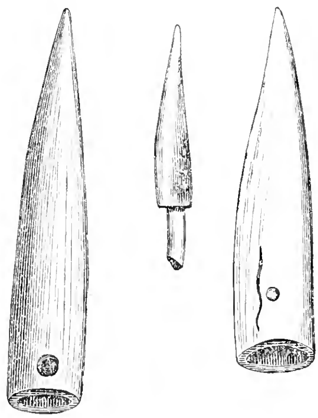

Fig. 5.

of an exactly similar make and of exactly the same sort of material are found thousands of miles away. Dr. F. Keller, in his elaborate book on the "Lake-Dwellers of Europe," gives figures† of these implements found in the Swiss lake-dwellings, and Fig. 5 is taken from his book. It is immediately seen that the relics from the two localities are identical, with the exception of the small hole drilled into the side. In Fig. 5 one of the arrow-points has a portion of the shaft still fastened in the hole.

Large pieces of deer and elk-horn, with the prongs polished by constant use, have probably been employed as digging implements. Smaller pieces of the flat part of the horn, with two or three prongs,

* Since this was written, Dr. Phené, of England, suggests that they were used as currency, and it is very possible that this was the case.

† See plates 45, 62, 89, and 91 for these figures. The ones here given are copied from Figs. 25 and 28 on plate 62, and Fig. 6 on plate 91.

like Fig. 6, have circular holes drilled into them, and were probably used for loosening the ground in agricultural labors. Here also we have similar pieces found in Switzerland, and Fig. 7 is copied from Dr. Kel-

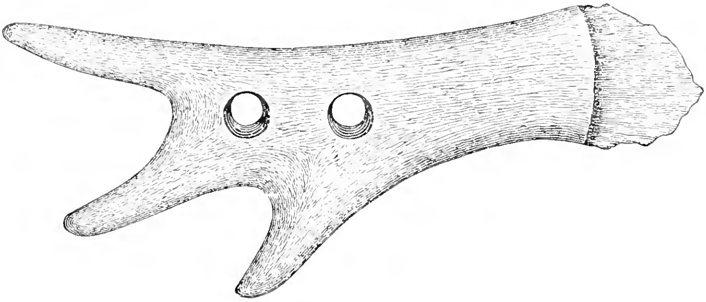

Fig. 6.

ler's book, before mentioned.* The same idea has evidently actuated the makers of both these articles. Still other implements of horn are known as skin-dressers. These are made of the broad bases of deer-horn, sometimes six or eight inches long and four inches wide. They

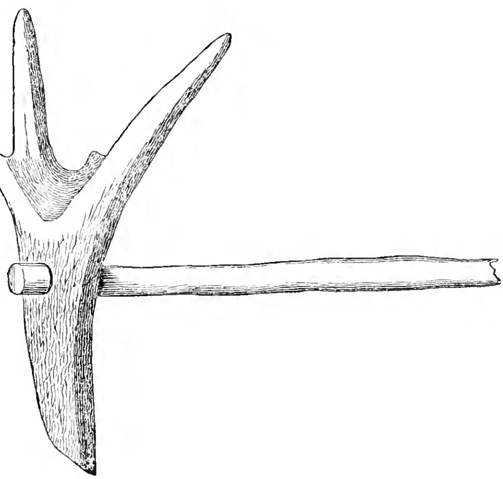

Fig. 7.

are polished at the broad end by constant use, so that they look like ivory. Occasionally one is found with a hole bored in it, but such are exceptional, and were perhaps used for another purpose. Here, again, we find relics of a similar character in Switzerland, as figured by Dr. Keller.†

Bone beads are also found with the other relics. These vary in length from one to three inches, and are often very highly polished.

* See plate 13, Fig. 2. † See plate 13, Fig. 14.

Fig. 8 is a large one, and has some peculiar zigzag markings on it, the significance of which is not known. Bone fish-hooks, as represented

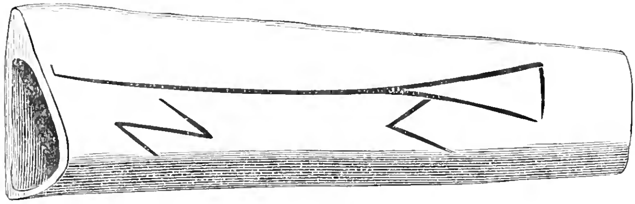

Fig. 8.

in Fig. 9, show the race to have lived by the product of the Little Miami River as well as by the chase. Bone harpoons, similar in make to those still in use by the Esquimaux,* show further that they derived sustenance from the river, while Fig. 10 shows a needle made of a fish-spine (*c*) with a large hole in one end, a deer-bone (*b*), used perhaps as an awl, and a turkey-bone (*a*), also used as an awl.

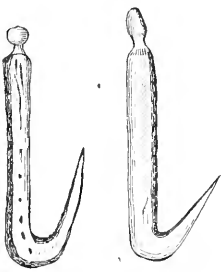

Fig. 9.

Besides the useful articles of bone that have been mentioned, there are others used more for ornament. The beads have already been referred to. A peculiarly-shaped piece of elk-horn, with five teeth and a perforated handle, has been found, and has been called a comb. Fig. 11 † represents it, and a striking resemblance between it and one from the Swiss lake-dwellings (Fig. 12 ‡) may be noticed. Another piece, the use of which is not known, but which is supposed to have been

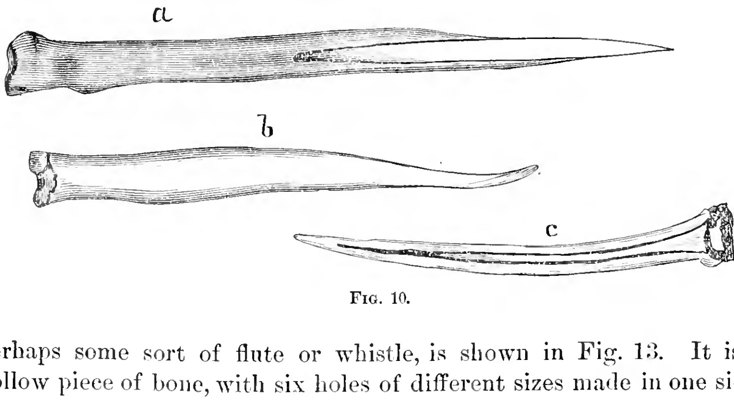

Fig. 10.

perhaps some sort of flute or whistle, is shown in Fig. 13. It is a hollow piece of bone, with six holes of different sizes made in one side,

* Lubbock, "Prehistoric Times," p. 504, Fig. 219.

† Copied from the "Journal of the Cincinnati Society of Natural History," vol. iii, p. 132.

‡ Keller, "Lake-Dwellings," plate 28, Fig. 8.

and marks of another where the relic has been broken. How much longer it was we can not tell. In Fig. 14 we have still another tube,

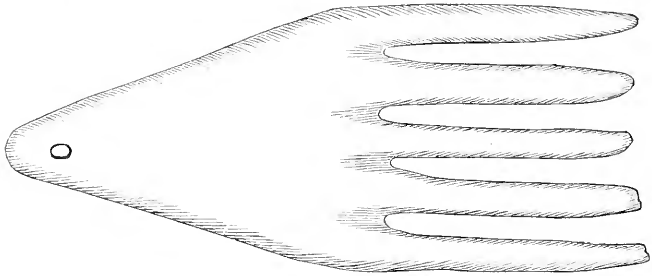

Fig. 11.

with only three holes, placed farther apart than in the preceding, and oblong instead of round; and in Keller* there is figured almost an

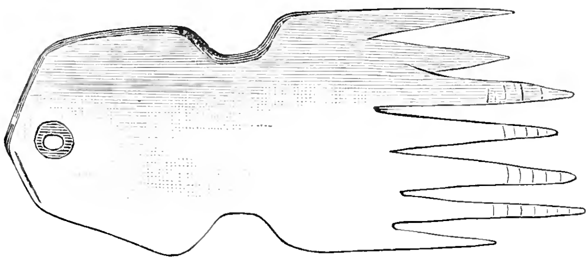

Fig. 12.

exact counterpart, except that the center hole is placed a little below the level of the other two. This last is called a weaver's shuttle, and, if our relic may be similarly named, we have evidence that weaving

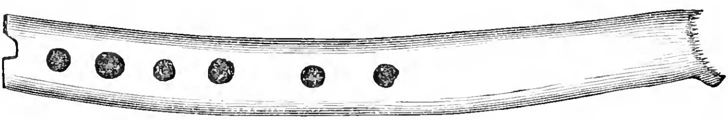

Fig. 13.

was another occupation of this people. And other facts are at hand to show that they did weave. Among the stone relics is one of those peculiar oblong pieces of polished slate which have sometimes gone by

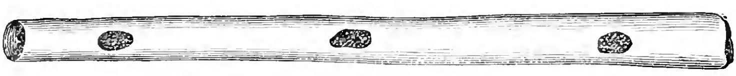

Fig. 14.

the name of "gorgets." These pieces have one to three holes drilled through them, supposed to have been made to carry the object by. Still another and more probable purpose, however, is for weaving, the

* *Loc. cit.*, plate 41, Fig. 9.

holes being used to regulate the size of the thread. But all doubt vanishes when it is found that some "ash-pits," in which most of the relics have been found, contain pieces of coarse matting. This has been carbonized, so that it can not now be ascertained of what material it was made. Enough, however, remains to show that the fibers running one way are secured by twisted cords running across, and woven in and out between and around them.

As is very well known, the copper-mines of Lake Superior were extensively worked at an early day, and articles made of the copper are found all through the valleys of the Mississippi and Ohio Rivers. The present cemetery is no exception, for fragments of copper are quite common. The pieces are mostly small, however, and do not seem to have been in very general use. In all probability the metal was highly prized, and used simply for personal adornment. The most of the pieces are simply coiled or rolled, and Fig. 15 represents

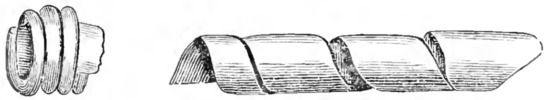

FIG. 15.

common shapes. These two pieces still have the remains of a leather thong in them, showing that they had been used like beads. Another piece is a sort of copper bell, made of a single piece of metal, with a hole in the side, a handle, and a small piece of copper inside, which rattles when the bell is shaken. Still another large piece is like a cross with two arms, the use or purpose of it being entirely unknown. Objects like it have occasionally been found elsewhere. Squier and Davis * have figured a similar piece, but of silver, which they refer to the French Jesuits; and Professor Putnam figures another, † which differs in having only one arm. He considers it an ornament, "made in its present form simply because it is an easy design to execute, and one of natural conception." We must beg leave to differ from him in this latter point, for, if the design is one of natural conception, why do we make a point when it is found? Why are the forms like it not more numerous, and why does not the ornamented pottery have innumerable examples of it in the ornamentation?

Beads made of pieces of fresh-water and marine shells are found among the other remains. Sometimes pieces are cut from the mussel-shell, rubbed round, and then a hole bored. Sometimes specimens of *Melania* or *Paludina* had holes bored near the aperture, and were then used as beads. The beads made of marine shells show that some system of barter or commerce existed with the Atlantic Ocean or the Gulf.

* "Ancient Monuments of the Mississippi Valley," p. 208.

† "Eleventh Annual Report of the Peabody Museum of Archæology and Ethnology," p. 307.

Quantities of shells, of species of the genus *Unio*, "fresh-water oysters," are found. They go to show that shell-fish formed an article of diet of the race. And not only did they eat the animal, but they made good use of many of the shells. Many of them have been ground off at the edge, and were used as spoons or ladles, while others have holes punched in the valves, and were probably used for hoes in their agricultural operations. An examination of many of these shells shows no difference between them and individuals of the same species now found in the river. Still, a change could hardly be expected in the inhabitants of any locality, without a change in the conditions of life, and there is no evidence of a change in conditions since the shells were taken from the river.

The flint pieces, of various shapes, are quite numerous, and many of them beautifully worked. In Fig. 16 are shown some of the war arrow-points, and they are so abundant that one is almost inclined to believe the people who made them were not so peaceable as has been supposed. In Fig. 17 is shown one of the "leaf-shaped" flints, some of which are beautifully worked; while, in Fig. 18 are some of the drills used in boring holes in bones or shells. There is one thing to be noticed among the flint pieces. It is said that, in war, arrows like those in Fig. 16 were exclusively used, while, in hunting, points which were notched at the broad or lower end were used. Now, the peculiarity noticed is the scarcity of points of the latter character. For, out of 316 worked flints, selected from some thousands, there are but four which are notched at the lower ends. One of two things is to be inferred. Either that the race was more warlike than agricultural,

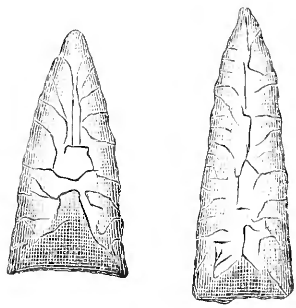

Fig. 16.

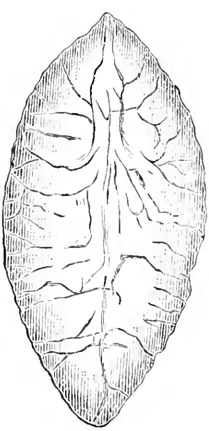

Fig. 17.

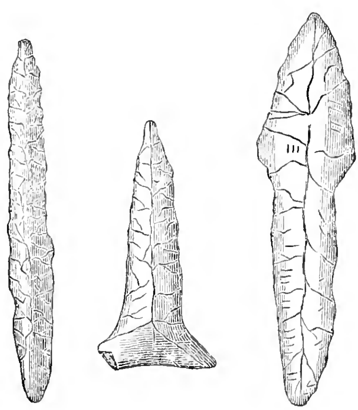

Fig. 18.

and used horn arrows in hunting instead of the notched ones; or else they were manufacturers of war-points for other tribes, and lived peaceably by hunting, fishing, and agricultural labors. All that we know could be interpreted more in favor of the first view than of the second, for, while we are sure they were agricultural to a certain extent, this fact would not be opposed to an argument for their warlike character. The Southern Indians, within the historic period, were at war all the time, and still raised quantities of maize.*

The fact of the race of people here buried raising maize is established by finding, in some pits, quantities of it completely carbonized. Corn seems to have often been placed in pots and buried with the bodies, to serve, perhaps, as food for the journey to the spirit-land. Another of their agricultural labors was that of raising tobacco; for, in common with nearly all the other North American races, they were smokers. Numbers of pipes, of various styles and materials, are found here. Some of them are of the red clay known as Catlinite, others of ordinary limestone. In Fig. 19 is shown a pipe carved out of hard

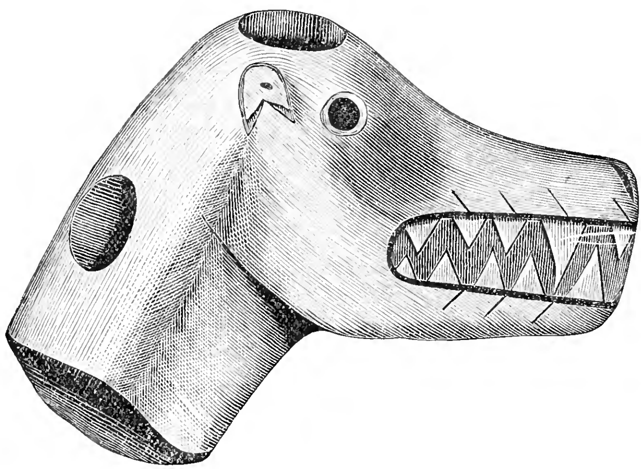

Fig. 19.

limestone. It is very highly polished, and considerable skill is exhibited in the carving of the head. It is evidently meant for a wolf, and the teeth, though interlocking in a peculiar way, are still tolerably true to nature in having the long canines.†

* Jones, "Antiquity of the Southern Indians," p. 7. "When, in 1730, the whites interposed their good offices to bring about a pacification between the Tuscaroras and the Cherokees, the latter responded: 'We can not live without war; should we make peace with the Tuscaroras, with whom we are at war, we must immediately look out for some other with whom we can be engaged in our beloved occupation.'" For notice of agricultural labors, see Jones, pp. 296 to 320.

† Many other forms of pipes from this locality are given in the "Journal of the Cincinnati Society of Natural History," vol. iii, Nos. 1, 2, and 3.

The stone implements are much the same as those found in various parts of the country. There seems, however, to be a remarkable paucity of grooved axes, there having been but two found so far. There are numbers of the ungrooved "celts," as well as of sling-stones, blunt at each end, but with a groove in the middle by which to fasten the handle. Some of these stones were also probably used as sinkers for nets in fishing, and are very similar to those found in Swiss lakes, as noticed by Dr. Keller. Rubbing-stones for polishing celts, hammers, anvils, pestles, and corn-pounders, are also abundant. Some pieces of a coarse, gritty sandstone have shallow grooves worn into them, which are supposed to have been used in rubbing down some of the bone or flint implements. Other pieces, with similar grooves, but made of close-grained sandstone, were probably used to straighten the shafts of the arrows. The shaft, at first wet and green, was rubbed up and down in the groove, and all the bends or twists thus taken out. Stones like these have been used by the Indians of the historic period.

Reference was made in the early part of this article to the name of the "Pottery-Field," given to the burying-ground. It may be inferred from the name that pieces of pottery were abundant, and the number of vessels taken out fully confirms the appropriateness of the name. These are all of one general shape and character. The material is a clay mixed with finely-powdered shells, and was baked in the sun. Nearly all the vessels are furnished with four handles, and are generally devoid of any ornamentation. Some have salamander-shaped handles, and the few that are ornamented have simply cross-lines and stripes with lines running round the vessel near the top, and perhaps a few dots. Though some of them are very well formed, they do not show any great advance in art.

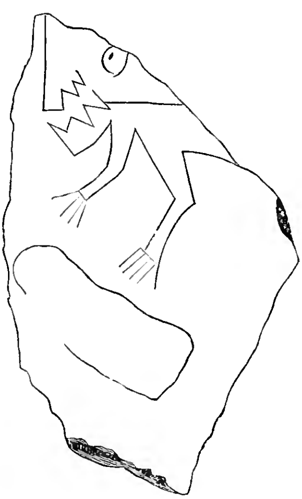

Fig. 20.

Among the most interesting remains of any race of people, are the rude beginnings of art they have left behind them; and, though the people under consideration did not have, as far as we know, any written language, they have left a few memorials of their artistic feelings in the shape of some carvings on bone, and a few inscribed stones. The most interesting of these are here figured. Fig. 20 represents, on a piece of limestone, the head and fore-legs of some curious animal. What is meant is hard to imagine. The teeth are marvelous, but still, in their arrangement, are like the teeth of the wolf-pipe in Fig. 19. Fig. 21 is a portion of a bone having peculiar marks cut on it. The marks are the same on both sides, but the meaning intended to be conveyed is beyond the interpreting powers of the writer, nor does he know of any explanation having been attempted.

From the remains here described, and from others found in the cemetery, for such the locality undoubtedly was, we can form some

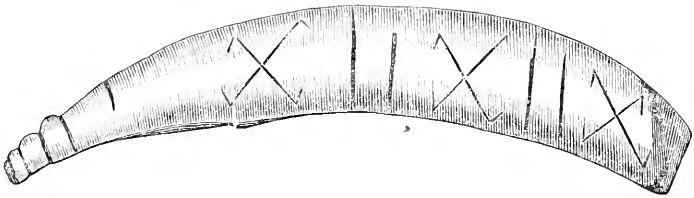

Fig 21.

idea of the habits of the people. They were warlike, yet agricultural, hunters as well as fishermen. They killed the bear, deer, elk, beaver, raccoon, and other animals of the forest, for the remains of all are quite abundant. They ate the shell-fish of the Little Miami River, and caught fish with hooks and nets. They raised corn, as well as tobacco, in quantities. They wove matting, made fish-nets, and perhaps blankets. They ornamented themselves with necklaces of bone and shell beads, bear and beaver teeth. They dressed in skins, prepared with horn and stone implements. They painted their bodies, as cakes of paint testify. They had commercial intercourse, or some system of barter, with Lake Superior and the Gulf, or the Atlantic. They were frequently embroiled in wars with neighboring tribes. They could hardly have been far advanced in civilization, if bone implements instead of stone is any indication. They had no written language, but yet left some record of their existence in the shape of carved bones and inscribed stones. Finally, if the burial of vessels containing food for the dead be any indication, they had some idea of a future life. Much further than this in their history we can not go.

The attention of the reader has been repeatedly called to the similarity between the implements found in this "Cincinnati" cemetery and those found in the Swiss lakes. No one could claim that, because of this similarity and almost identity of forms, the two races of people ever had intercourse with each other. But the fact is interesting as showing how, in two countries, thousands of miles apart, and separated by a period of hundreds of years in time, there were made, with the same materials, the same forms of weapons and implements. The resemblance is no argument for a common origin, but simply shows that nearly the same grade of civilization may be developed spontaneously in two widely separated countries.

It now becomes an interesting matter of speculation to discover the age of the cemetery. It has been referred to the age of the mound-builders, but, if so, it is a most remarkable fact, unless we consider the modern Indians as the lineal descendants of the mound-builders, which is quite probable. Heretofore but three or four authentic skulls of the mound-builders have been found in any sort of preservation, while here we have a great many taken from a small area. Further, if we are to refer the cemetery to the mound-building race, we must admit that the race disappeared within a very recent period. On a level bank near the Little Miami River is a circular excavation about forty feet in diameter and seven feet deep. "An old settler relates that fifty years ago remains of stakes or palisades could be seen surrounding this excavation." * These have since disappeared, but their being there shows within how recent a period the ground was abandoned. Then the age of the forest-trees growing on the ground argues against any very great antiquity. The largest trees measured are a walnut fifteen and a half feet in circumference, an oak twelve feet, an oak and a maple each nine and a half feet in circumference, † equal to about five, four, and three feet in diameter respectively. Now, the average growth of fourteen different species of trees is about ·12 of an inch a year, or one foot radius (two feet diameter) in ninety-eight years. ‡ Taking this average, a tree five feet in diameter would be two hundred and forty-five years old; one four feet in diameter, one hundred and ninety-six years old; and one three feet in diameter, one hundred and forty-seven years old; or, in round numbers, two hundred and fifty, two hundred, and one hundred and fifty years respectively.

There is no evidence to show that there was any growth of forest on this ground, after its abandonment by the former residents, previous to the one now covering it. The roots of living trees having trunks two and three feet in diameter have been found penetrating the crania of skeletons found here, a tolerably sure indication of a first growth. Notwithstanding the assertions of many people to the contrary, the process of covering land with dense forest is by no means a slow one. A field allowed to go without being cultivated becomes in a few years covered with a new growth of saplings. Mr. Robert Ridgway, in a late paper, after referring to the cutting off of timber, and also to its encroachment on prairie-land in Illinois, says: "The growth of this new forest is so rapid that extensive woods near Mount Carmel [Illinois], consisting chiefly of oaks and hickories (averaging more than eighty feet high, one to nearly two feet in diameter), were open prairie within the memory of some of the present owners of the land." # Taking this fact into consideration, and remembering that

* "Prehistoric Monuments of the Little Miami Valley," by Dr. Charles Metz, "Journal of the Cincinnati Society of Natural History," vol. i, p. 123.

† Ibid., vol. iii, p. 44.

‡ See table, by Dr. A. Lapham, of age of trees in Wisconsin, given in Foster's "Prehistoric Races of the United States," p. 374.

\# "Notes on the Native Trees of the Lower Wabash and White River Valleys in the largest tree found on the ground was not over two hundred and fifty years old, the time of the abandonment of the cemetery can not be more than three hundred years ago. This would take it back to less than one hundred years after the discovery of America by Columbus. The present State of Ohio was then probably occupied by a tribe of Indians known as the Eries, who were totally exterminated in 1656,* and it is possible we have in this cemetery one of the burial-places of this tribe of Indians.

Catlinite pipes were unknown to the mound-builders, yet some made of this material are found in this cemetery. Hogs rooting in the ground find sufficient nutriment in the bones to eat them greedily, and probably there would be fewer bone implements found if they had not been buried in ash-pits.† Everything, therefore, tends to show the comparatively recent date of this cemetery, and I would state, as a reasonable conclusion, that the remains are those of a tribe of Indians, perhaps the Eries, and were deposited not more than three hundred and perhaps only two hundred and fifty years ago.

THE UNIVERSITY IDEAL.‡

By ALEXANDER BAIN, LL. D.

GENTLEMEN: By your flattering estimate of my services, I have been unexpectedly summoned from retirement to assume the honors and the duties of the purple, and to occupy the most historically important office in the universities of Europe.

The present demands upon the rectorship somewhat resemble what we are told of the Homeric chief, who, in company with his council or senate, the *Boulē*, and the popular assembly, or *Agora*, made up the political constitution of the tribe. The functions of the chief, it is said, were to supply wise reason to the *Boulē* (as we might call our court), and unctuous eloquence to the *Agora*. The second of these requirements is what weighs upon me at the present moment.

Whatever may have been the practice of my predecessors, generally strangers to you, it would be altogether unbecoming in me to travel out of our university life for the materials of an address. My remarks, then, will principally bear on the UNIVERSITY IDEAL.

Illinois and Indiana," printed in "Proceedings of the United States National Museum," 1882, p. 54.

* "Some Early Notices of the Indians of Ohio," by M. F. Force, published by R. Clarke & Co., Cincinnati, 1879, pp. 1–11.

† For an account of these pits, see "Journal of the Cincinnati Society of Natural History," vol. iii.

‡ Rectorial Address to the Students of Aberdeen University, Wednesday, November 15, 1882.

To the Greeks we are indebted for the earliest germ of the university. It was with them chiefly that education took that great leap, the greatest ever made, from the traditional teaching of the home, the shop, the social surroundings, to schoolmaster teaching properly so called. Nowadays, we schoolmasters think so much of ourselves, that we do not make full allowance for that other teaching which was, for unknown ages, the only teaching of mankind. The Greeks were the first to introduce, not perhaps the primary schoolmaster for the R's, but certainly the secondary or higher schoolmaster, known as rhetorician or sophist, who taught the higher professions ; while their philosophers or wise men introduced a kind of knowledge that gave scope to the intellectual faculties, with or without professional applications ; the very idea of our Faculty of Arts.

So self-asserting were these new-born teachers of the sophist class, that Plato thought it necessary to recall attention to the good old perennial source of instruction—the home, the trade, and the society. He pointed out that the pretenders to teach virtue by moral lecturing were as yet completely outrivaled by the influence of the family and the social pressure of the community. In like manner the arts of life were all originally handed down by apprenticeship and imitation. The greatest statesmen and generals of early times had simply the education of the actual work. Philip of Macedon could have had no other teaching ; his greater son was the first of the line to receive what we may call a liberal or a general education, under the educator of all Europe.

I must skip eight centuries to introduce the man that linked the ancient and the modern world, and was almost the sole luminary in the West during the dark ages, namely, Boëthius, minister of the Gothic Emperor Theodoric. As much of Aristotle as was known between the sixth and the eleventh centuries was handed down by him. During that time only the logical treatises existed among the Latins ; and of these the best parts were neglected. Historical importance attaches to a small circle of them known as the Old Logic (*vetus logica*), which were the pabulum of abstract thought for five dreary centuries. These consisted of the two treatises or chapters of Aristotle called the "Categories," and the "De Interpretatione," or the theory of propositions ; and of a book of Porphyry, the neo-Platonist, entitled "Introduction" (*Isagoge*), and treating of the so-called Five Predicables. A hundred average pages would include them all ; and three weeks would suffice to master them.

Boëthius, however, did much more than hand on these works to the mediæval students ; he translated the whole of Aristotle's logical writings (the "Organon"), but the others were seldom taken up. It was he too that handled the question of universals in his first Dialogue on Porphyry, and sowed the seed that was not to germinate till four centuries afterward, but which, when the time came, was to bear fruit in no measured amount. And Boëthius is the name associated with the scheme of higher education that preceded the university teaching, called the *quadrivium*, or quadruple group of subjects, namely, arithmetic, geometry, music, and astronomy. This, together with the *trivium*, or preparatory group of three subjects—grammar, rhetoric, and logic—constituted what was known as the *seven liberal arts;* but, in the darkest ages, the quadrivium was almost lost sight of, and few went beyond the trivium.

In the seventh century, the era of deepest intellectual gloom, philosophy was at an entire stand-still. Light arises with the eighth, when we are introduced to the cathedral and cloister schools of Charlemagne; and the ninth saw these schools fully established, and an educational reform completed that was to be productive of lasting good results. But the range of instruction was still narrow, scarcely proceeding beyond the Old Logic, and the teachers were, as formerly, the monks. The eleventh century is really the period of dawn. The East was now opened up through the Crusades, and there was frequent intercourse with the learned Saracens of Spain; and thus there were brought into the West the whole of Aristotle's works, with Arabic commentaries, chiefly in Latin translations. The effervescence was prodigious and alarming. The schools were re-enforced by a higher class of teachers, lay as well as clerical; a marked advance was made in Logic and Dialectic; and the great controversy of realism *versus* nominalism, which had found its birth in the previous century, raged with extraordinary vigor. We are now on the eve of the founding of the universities; Bologna, indeed, being already in existence.

The university proper, however, can hardly be dated earlier than the twelfth century; and the important particulars in its first constitution are these:

First, the separation of philosophy from theology. To expound this, would be to give a chapter of mediæval history. Suffice it to say that Aristotle and the awakening intellect of the eleventh century were the main causes of it. Two classes of minds at this time divided the Church—the pious, devout believers (such as St. Bernard), who needed no reasons for their faith, and the polemic speculative divines (such as Abélard), who wished to make theology rational. It was an age, too, of stirring political events; the crusading spirit was abroad, and found a certain gratification even in the war of words. The nature of universals was eagerly debated; but, when this controversy came into collision with such leading theological doctrines as the Trinity and predestination, it was no longer possible for philosophy and theology to remain conjoined.

A separation was effected, and determined the leading feature of the university system. The foundation was philosophy, and the fundamental faculty the Faculty of Arts. Bologna, indeed, was eminent for law or jurisprudence, and this celebrity it retained for ages; but the University of Paris, which is the prototype of our Scottish universities, as of so many others, taught nothing but philosophy—in other words, had no faculty but arts—for many years. Neither theology, medicine, nor law had existence there till the thirteenth century.

Second, the system of conferring degrees, after appropriate trials. These were at first simply a license to teach. They acquired their commanding importance through the action of Pope Nicholas I, who gave to the graduates of the University of Paris the power of teaching everywhere, a power that our own countrymen were the foremost to turn to account.

Third, the organization of the primitive university. Europe was unsettled; even in the capitals, the civil power was often unhinged. Wherever multitudes came together, there was manifested a spirit of turbulence. The universities often exemplified this fact; and it was found necessary to establish a government within themselves. The basis was popular; but, while in Paris only the teaching body was incorporated, in Bologna the students had a voice. They elected the rector, and his jurisdiction was very great indeed, and much more important than speechifying to his constituents. His court had the power of internal regulation, with both a civil and criminal jurisdiction. The Scotch universities, on this point, followed Bologna; and that fact is the remote cause of this day's meeting.

So started the university. The idea took; and, in three centuries, many of the leading towns in Italy, France, the German Empire, had their universities; in England arose Oxford and Cambridge; the model was Paris or Bologna.

Scotland did not at first enter the race of university founding, but worked on the plan of the cuckoo, by laying its eggs in the nests of others. For two centuries, Scotchmen were almost shut out of England; and so could not make for themselves a career in Oxford and Cambridge, as in later times. They had, however, at home, good grammar-schools, where they were grounded in Latin. They perambulated Europe, and were familiar figures in the great university towns, and especially Paris. From their disputatious and metaphysical attitude they worked their upward way:

> "And gladly would they learn and gladly teach."

At length, the nation did take up the work in good earnest. In 1411 was founded the first of the St. Andrews' Colleges; 1451 is the date of Glasgow; 1494, King's College, Aberdeen. These are the pre-Reformation colleges; but for the Reformation, we might not have had any other. Their founders were ecclesiastics; their constitution and ceremonial were ecclesiastical. They were intended, no doubt, to keep the Scotch students at home. They were also expected to serve as bulwarks to the Church against the rising heretics of the times. In this they were disappointed; the first-begotten of them became the cradle of the Reformation.

In these our three eldest foundations we are to seek the primitive constitution and the teaching system of our universities. In essentials, they were the same; only between the dates of Glasgow and Old Aberdeen occurred two great events. One was the taking of Constantinople, which spread the Greek scholars with their treasures over Europe. The other was the progress of printing. In 1451, when Glasgow commenced, there was no printed text-book. In 1494, when King's College began, the ancient classics had been largely printed; the early editions of Aristotle in our library show the date of 1486.

Our universities have three well-marked periods; the first anterior to the Reformation; the second, from the Reformation to the beginning of last century; the third, the last and present centuries. Confining ourselves still to the Faculty of Arts, the features of the pre-Reformation university were these:

First, as regards the teaching body. The quadrennial arts' course was conducted by so-called regents, who each carried the same students through all the four years, thus taking upon himself the burden of all the sciences—a walking encyclopædia. The system was in full force, in spite of attempts to change it, during both the first and the second periods. You, the students of arts, at the present day, encountering, in your four years, seven faces, seven voices, seven repositories of knowledge, need an effort to understand how your predecessors could be cheerful and happy, confined all through to one personality; sometimes juvenile, sometimes senile, often feeble at his best.

Next, as regards the subjects taught. To know these you have simply to know what are the writings of Aristotle. The little work on him by Sir Alexander Grant supplies the needful information. The records of the Glasgow University furnish the curriculum of Arts soon after its foundation. The subjects are laid out in two heads—Logic and Philosophy. The Logic comprised first the three Treatises of the Old Logic; to these were now added the whole of the works making up Aristotle's "Organon." This brought in the Syllogism and allied matters. There was, also, a selection from the work known as the "Topics," not now included in logical teaching, yet one of the most remarkable and distinctive of Aristotle's writings. It is a highly-labored account of the whole art of disputation, laid out under his scheme of the Predicables. The selection fell chiefly on two books—the second, comprising what Aristotle had to say on Induction, and the sixth, on Definition; together with the "Logical Captions," or Fallacies. Disputation was one of the products of the Greek mind; and Aristotle was its prophet.

Now for Philosophy. This comprised nearly the whole of Aristotle's Physical treatises—his very worst side—together with his Metaphysics, some parts of which are hardly distinguishable from the Physics. Next was the very difficult treatise—"De Anima," on the Mind, or Soul—and some allied psychological treatises, as that on

Memory. Such was the ordinary and sufficing curriculum. It was allowed to be varied with a part of the Ethics; but in this age we do not find the Politics; and the Rhetoric is never mentioned. So, also, the really valuable biological works of Aristotle, including his book on Animals, appear to have been neglected.

Certain portions of Mathematics always found a place in the curriculum. Likewise, some work on Astronomy, which was one of the quadrivium subjects.

All this was given in Latin. Greek was not then known (it was introduced into Scotland in 1534). No classical Latin author is given; the education in Latin was finished at the Grammar School.

Such was the Arts' Faculty of the fifteenth century: a dreary, single-manned, Aristotelian quadriennium. The position is not completely before us till we understand further the manner of working.

The pupils could not, as a rule, possess the text of Aristotle. The teacher read and expounded the text for them; but a very large portion of the time was always occupied in dictating, or "diting," notes, which the pupils were examined upon, *viva voce;* their best plan usually being to get them by heart, as any one might ask them to repeat passages literally, while perhaps few could examine well upon the meaning. The notes would be selections and abridgments from Aristotle, with the comments of modern writers. The "diting" system was often complained of as a waste of time, but was not discontinued till the third, or present, university dynasty, and not entirely then, as many of us know.

The teaching was thus exclusively *text* teaching. The teacher had little or nothing to say for himself (at least in the earliest period). He was even restricted in the remarks he might make by way of commentary. He was as nearly as possible a machine.

But, lastly, to complete the view of the first period, we must add the practice of disputation, of which we shall have a better idea from the records of the next period. This practice was coeval with the universities; it was the single mode of stimulating the thought of the individual student; the chief antidote to the mechanical teaching by text-books and dictation.

The pre-Reformation period of Aberdeen University was little more than sixty years. For a portion of those years it attained celebrity. In 1541 the town was honored by a visit from James V, and the university contributed to his entertainment. The somewhat penny-a-lining account is, that there were exercises and disputations in Greek, Latin, and other languages! The official records, however, show that the college at that very time had sunk into a convent and conventual school.

The Reformation introduced the second period, and made important changes. First of all, in the great convulsion of European thought, the ascendency of Aristotle was shaken. It is enough to mention two incidents in the downfall of the mighty Stagyrite. One was the attack on him by the renowned Peter Ramus, in the University of Paris. Our countryman, Andrew Melville, attended Ramus's Lectures, and became the means of introducing his system into Scotland. The other incident is still more notable. The Reformers had to consider their attitude toward Aristotle. At first their opinion was condemnatory. Luther regarded him as a very devil; he was "a godless bulwark of the papists." Melanchthon was also hostile; but he soon perceived that Theology would crumble into fanatical dissolution without the co-operation of some philosophy. As yet there was nothing to fall back upon except the pagan systems. Of these, Melanchthon was obliged to confess that Aristotle was the least objectionable, and was, moreover, in possession. The plan, therefore, was to accept him as a basis, and fence him round with orthodox emendations. This done, Aristotle, no longer despotic, but as a limited constitutional monarch, had his reign prolonged a century and a half.

The first thing, after the Reformation in Scotland, was to purge the universities of the inflexible adherents of the old faith. Then came the question of amending the curriculum, not simply with a view to Protestantism, but for the sake of an enlightened teaching. The right man appeared at the right moment. In 1574 Andrew Melville, then in Geneva, received pressing invitations to come home and take part in the needed reforms. He was immediately made Principal of Glasgow University, at that time in a state of utter collapse and ruin. He had matured his plans, after consultation with George Buchanan, and they were worthy of a great reformer. He sketched a curriculum, substantially the curriculum of the second university period. The modifications upon the almost exclusive Aristotelianism of the first period were significant. The Greek language was introduced, and Greek classical authors read. The reading in the Roman classics was extended. A text-book on rhetoric accompanied the classical readings. The dialectics of Ramus made the prelude to Logic, instead of the three treatises of the Old Logic. The mathematics included Euclid. Geography and Cosmography were taken up. Then came a course of Moral Philosophy on an enlarged basis. With the Ethics and Politics of Aristotle were combined Cicero's ethical works and certain Dialogues of Plato. Finally, in the physics, Melville still used Aristotle, but along with a more modern treatise. He also gave a view of universal history and chronology.

This curriculum, which Melville took upon himself to teach, in order to train future teachers, was the point of departure of the courses in all the universities during the second period. With variations of time and place, the Arts' course may be described as made up of the Greek and Latin classics, with rhetoric, logic, and dialectics, moral philosophy or ethics, mathematics, physics, and astronomy. The little text-book of rhetoric, by Talon or Talæus, was made up of notes from the Lectures of Peter Ramus, and used in all our colleges till superseded by the better compilation of the Dutch scholar, Gerard John Voss.

Melville had to contend with many opponents, among them the sticklers for the infallibility of the Stagyrite. Like the German Reformers, he had accepted Aristotelianism as a basis, with a similar process of reconciliation. So it was that Aristotle and Calvin were brought to kiss each other.

Melville's next proposal was all too revolutionary. It consisted in restricting the regents each to a special group of subjects; in fact, anticipating our modern professoriate. He actually set up this plan in Glasgow: one regent took Greek and Latin; another, his nephew, James Melville, took mathematics, logic, and moral philosophy; a third, physics and astronomy. The system went on, in appearance, at least, for fifty years; it is only in 1642 that we find the regents given without a specific designation. Why it should have gone on so long, and been then dropped, we are not informed. Melville's influence started it in the other universities, but it was defeated in every one from the very outset. After six years at Glasgow, he went to St. Andrews as Principal and Professor of Divinity, and tried there the same reforms, but the resistance was too great. In spite of a public enactment, the division of labor among the regents was never carried out. Yet, such was Melville's authority, that the same enactment was extended to King's College, in a scheme having a remarkable history—the so-called New Foundation of Aberdeen University, promulgated in a royal charter of about the year 1581. The Earl Marischal was a chief promoter of the plan of reform comprised in this charter. The division of labor among the regents was most expressly enjoined. The plan fell through; and there was a legal dispute fifty years afterward as to whether it had ever any legal validity. Charles I was made to express indignation at the idea of reducing the university to a school!

We now approach the foundation of Marischal College. The Earl Marischal may have been actuated by the failure of his attempt to reform King's College. At all events, his mind was made up to follow Melville in assigning separate subjects to his regents. The charter is explicit on this head. Yet, in spite of the charter and in spite of his own presence, the intention was thwarted; the old regenting lasted one hundred and sixty years.

Still the curriculum reform was gained. There was, indeed, one great miss. The year before Marischal College was founded, Galileo had published his work on mechanics, which, taken with what had been accomplished by Archimedes and others, laid the foundations of our modern physics. Copernicus had already published his work on the heavens. It was now time that the Aristotelian Physics should be clean swept away. In this whole department, Aristotle had made a reign of confusion; he had thrown the subject back, being himself off the rails from first to last. Had there been in Scotland an adviser in this department, like Melville in general literature, or like Napier of Merchiston in pure mathematics, one fourth of the college teaching might have been reclaimed from utter waste, and a healthy tone of thinking diffused through the remainder.

A curious fascination always attached to the study of astronomy, even when there was not much to be said, apart from the unsatisfactory disquisition of Aristotle. A little book, entitled "*Sacrobosco* on the Sphere," containing little more than what we should now teach to boys and girls, along with the globes, was a university text-book throughout Europe for centuries. I was informed by a late King's College professor that the use of the globes was, within his memory, taught in the Magistrand Class. This would be simply what is termed a "survival."

Now, as to the mode of instruction. There were *viva-voce* examinations upon the notes, such as we can imagine. But the stress was laid on disputations and declamations in various forms. Besides disputing and declaiming on the regular class-work before the regent, we find that, in Edinburgh, and I suppose elsewhere, the classes were divided into companies, who met apart, and conferred and debated among themselves daily. The students were occupied, altogether, six hours a day. Then the higher classes were frequently pitched against each other. This was a favorite occupation on Saturdays. The doctrines espoused by the leading students became their nicknames. The pass for graduation consisted in the *propugning* or *impugning* of questions by each candidate in turn. An elaborate thesis was drawn up by the regent, giving the heads of his philosophy course; this was accepted by the candidates, signed by them, and printed at their expense. Then on the day of trial, at a long sitting, each candidate stood up and propugned or impugned a portion of the thesis; all were heard in turn; and on the result the degree was conferred. A good many of these theses are preserved in our library; some of them are very long—a hundred pages of close type; they are our best clew to the teaching of the period. We can see how far Aristotle was qualified by modern views.

I said there might have been times when the students never had the relief of a second face all the four years. The exceptions are of importance. First, as regards Marischal College. Within a few years of the foundation, Dr. Duncan Liddell founded the Mathematical chair, and thus withdrew from the regents the subject that most of all needed a specialist; a succession of very able mathematicians sat in this chair. King's College had not the same good fortune. From its foundation it possessed a separate functionary, the Humanist or Grammarian; but he had also, till 1753, to act as Rector of the Grammar School. Edinburgh obtained from an early date a Mathematical chair, occupied by men of celebrity. There was no other innovation till near the end of the seventeenth century, when Greek was isolated both in Edinburgh and in Marischal College ; but the end of regenting was then near.

The old system, however, had some curious writhings. During the troubled seventeenth century, university reform could not command persistent attention. But, after the 1688 Revolution, opinions were strongly expressed in favor of the Melville system. The obvious argument was urged that, by division of labor, each man would be able to master a special subject, and do it justice in teaching. Yet, it was replied that, by the continued intercourse, the masters knew better the humors, inclinations, and talents of their scholars. To which the answer was—the humors and inclinations of scholars are not so deeply hid but that in a few weeks they appear. Moreover, it was said, the students are more respectful to a master while he is new to them.

The final division of subjects took place in Edinburgh in 1708 ; in Glasgow, in 1727 ; in St. Andrews, in 1747. In Marischal College, the change was made by a minute of January 11, 1753 ; but, whether from ignorance, or from want of grace, the Senatus did not record its satisfaction at having, after a lapse of five generations, fulfilled the wishes of the pious founder. In King's College the old system lasted till 1798.

This closes the second age of the universities, and introduces the third age, the age of the professoriate, of lecturing instead of text-books, the end of disputation, and the use of the English language. It was now, and not till now, that the Scottish universities stood forth, in several leading departments of knowledge, as the teachers of the world.

The second age of the universities was Scotland's most trying time. In a hundred and thirty years, the country had passed through four revolutions and counter-revolutions ; every one of which told upon the universities. The victorious party imposed its test upon the university teachers, and drove out recusants. You must all know something of the purging of the university and the ministry of Aberdeen by the Covenanting General Assembly of 1640. These deposed Aberdeen doctors may have had too strong leanings to episcopacy in the church and to absolutism in the state, but they were not Vicars of Bray. The first half of the century was adorned by a band of scholars, who have gained renown by their cultivation of Latin poetry ; a little oasis in the desert of Aristotelian dialectics. It would be needless and ungracious to inquire whether this was the best thing that could have been done for the generation of Bishop Patrick Forbes.

Your reading in the history of Scotland will thus bring you face to face with the great powers that contended for the mastery from 1560 : the monarchy, always striving to be absolute ; the Church, whose position made it the advocate of popular freedom ; the universities, fluctuating as regards political liberty, but standing up for intellectual liberty. In the seventeenth century the Church ruled the universities; in the eighteenth, it may be said that the universities returned the compliment.

Enough for the past. A word or two on the present. What is now the need for a university system, and what must the system be to answer that need? Many things are altered since the twelfth century.

First, then, universities, as I understand them, are not absolutely essential to the teaching of professions. Let me make an extreme supposition. A great naval commander, like Nelson, is sent on board ship, at eleven or twelve; his previous knowledge, or general training, is what you may suppose for that age. It is in the course of actual service, and in no other way, that he acquires his professional fitness for commanding fleets. Is this right or is it wrong? Perhaps it is wrong, but it has gone on so for a long time. Well, why may not a preacher be formed on the same plan? John Wesley was not a greater man in preaching than Nelson in seamanship. Take, then, a youth of thirteen from the school. Apprentice him to the minister of the parish. Let him make at once preparations for clerical work. Let him store his memory with sermons, let him make abstracts of divinity systems; master the best exegetical commentators. Then, in a year or two, he would begin to catechise the young, to give addresses in the way of exposition, exhortation, encouragement, and rebuke. Practice would bring facility. Might not, I say, seven years of the actual work, in the susceptible period of life, make a preacher of no mean power, without the grammar-school, without the Arts classes, without the Divinity Hall?

What, then, do we gain by taking such a roundabout approach to our professional work? The answer is twofold:

First, as regards the profession itself. Nearly every skilled occupation, in our time, involves principles and facts that have been investigated, and are taught, outside the profession; to the medical man are given courses of chemistry, physiology, and so on. Hence, to be completely equipped for your professional work, you must repair to the teachers of those tributary departments of knowledge. The requirement, however, is not absolute; it admits of being evaded. Your professional teachers ought to master these outside subjects, and give you just so much of them as you need, and no more; which would be an obvious economy of your valuable time.

Thus, I apprehend, the strictly professional uses of general knowledge fail to justify the grammar-school and the Arts' curriculum. Something, indeed, may still be said for the higher grades of professional excellence, and for introducing improved methods into the practice of the several crafts, for which wider outside studies lend their aid. This, however, is not enough; inventors are the exception. In fact, the ground must be widened, and include, secondly, *the life beyond the profession.* We are citizens of a self-governed country; members of various smaller societies; heads or members of families. We have, moreover, to carve out recreation and enjoyment as the alternative and the reward of our professional toil. Now, the entire tone and character of this life outside the profession are profoundly dependent on the compass of our early studies. He that leaves the school for the shop at thirteen is on one platform. He that spends the years from thirteen to twenty in acquiring general knowledge is on a totally different platform; he is, in the best sense, an aristocrat. Those that begin work at thirteen, and those that are born not to work at all, are alike his inferiors. He should be able to spread light all around. He it is that may stand forth before the world as the model man.

All this supposes that you realize the position; that you fill up the measure of the opportunities; that you keep in view at once the professional life, the citizen life, and the life of intellectual tastes. The mere professional man, however prosperous, can not be a power in society, as the Arts' graduate may become. His leisure occupations are all of a lower stamp. He does not participate in the march of knowledge. He must be aware of his incompetence to judge for himself in the greater questions of our destiny; his part is to be a follower, and not a leader.

It is not, then, the name of graduate that will do all this. It is not a scrape pass; it is not decent mediocrity with a languid interest. It is a fair and even attention throughout, supplemented by auxiliaries to the class-work. It is such a hold of the leading subjects, such a mastery of the various alphabets, as will make future references intelligible, and a continuation of the study possible.

Our curriculum is one of the completest in the country, or perhaps anywhere. By the happy thought of the Senatus of Marischal College, in 1753, you have a fundamental class not existing in the other colleges. You have a fair representation of the three great lines of science—the abstract, the experimental, and the classifying. When it is a general education that you are thinking of, every scheme of option is imperfect that does not provide for such three-sided cultivation of our reasoning powers. A larger quantity of one will no more serve for the absence of the rest than a double covering of one part of the body will enable another part to be left bare.

Your time in the Arts' curriculum is not entirely used up by the classes. You can make up for deficiencies in the course when once you have formed your ideal of completeness. For a year or two after graduating, while still rejoicing in youthful freshness, you can be widening your foundations. The thing, then, is to possess a good scheme and to abide by it. Now, making every allowance for the variation of tastes and of circumstances, and looking solely to what is desirable for a citizen and a man, it is impossible to refuse the claims of the department of Historical and Social study. One or two good representative historical periods might be thoroughly mastered, in conjunction with the best theoretical compends of Social Philosophy.

Further, the ideal graduate, who is to guide and not follow opinion, should be well versed in all the bearings of the Spiritual Philosophy of the time. The subject branches out into wide regions, but not wider than you should be capable of following it. This is not a professional study merely ; it is the study of a well-instructed man.

Once more. A share of attention should be bestowed early on the higher literature of the imagination. As, in after-life, poetry and elegant composition are to be counted on as a pleasure and solace, they should be taken up at first as a study. The critical examination of styles, and of authors, which forms an admirable basis of a student's society, should be a work of study and research. The advantages will be many and lasting. To conceive the exact scope and functions of the imagination in art, in science, in religion, and everywhere, will repay the trouble.

Ever since I remember, I have been accustomed to hear of the superiority of the Arts' graduate, in various crafts, more especially as a teacher. Many of you in these days pass into another vocation—letters, or the press. Here, too, almost everything you learn will pay you professionally. Still, I am careful not to rest the case for general education on professional grounds alone. I might show you that the highest work of all—original inquiry—needs a broad basis of liberal study ; or, at all events, is vastly aided by that. Genius will work on even a narrow basis, but imperfect preparatory study leaves marks of imperfection in the product.

The same considerations that determine your voluntary studies determine also the university ideal. A university, in my view, stands or falls with its Arts' faculty. Without debating the details, we may say that this faculty should always be representative of the needs of our intelligence, both for the professional and for the extra-professional life ; it should not be of the shop, shoppy. The university exists because the professions would stagnate without it ; and, still more, because it may be a means of enlarging knowledge at all points. Its watchword is progress. We have, at last, the division of labor in teaching ; outside the university, teachers too much resemble the regent of old—having too many subjects, and too much time spent in grinding. Our teachers are exactly the reverse.

Yet, there can not be progress without a sincere and single eye to the truth. The fatal sterility of the middle ages, and of our first and second university periods, had to do with the mistake of gagging men's mouths, and dictating all their conclusions. Things came to be so arranged that contradictory views ran side by side, like opposing electric currents; the thick wrappage of ingenious phraseology arresting the destructive discharge. There was, indeed, an elaborate and pretentious logic, supplied by Aristotle, and amended by Bacon; what was still wanted was a taste of the logic of freedom.

CURIOSITIES OF SUPERSTITION.

By FELIX L. OSWALD, M. D.

II.

DURING the reign of Philip II of Spain, the Government spies in the province of Malaga made a curious discovery. In the highest valleys of the Alpujarras, and surrounded by a population of recently converted Moors, they found a tribe of mountaineers whose vernacular was as different from the Arabian as from the Spanish language, and whose neighbors believed them to be descendants of the ancient Iberians. The Ghabirs, as the Moors called them, were a most primitive and harmless race, their food consisted of the vegetable products of their peaceful valley, their only religious function in sacrificing milk and fruits to the spirit of the mountains. A few weeks after the discoverer had made his report to the Holy Office, a detachment of troopers and monks invaded the Alpujarras, the Ghabirs were dragged to Velez Malaga, and burned by order of the Grand Inquisitor. Their crime could not be condoned: they had disregarded the proclamation of 1562, and evaded tithes and baptism for seven years. In vain they pleaded their poverty, their ancient customs, and their ignorance of the Spanish language; "they were all invested with the *sanbenito*," says the chronicler, "and broiled to death with the proper ceremonies." The shrieks of the victims were heard at Loja, and for three days the harbor of Velez was filled with the stench of burned human flesh. It was a most edifying *auto da fe*—"an act of faith." The same faith had filled the Netherlands with blood and horror, had raged like the Black Death among the helpless aborigines of the New World, and had orthodoxed Spain by the systematic suppression of freedom, common sense, manhood, industry, and science.

And yet that monstrous superstition had undoubtedly supporters who honestly mistook it for the purest and most beneficent of all possible creeds. But we may be equally sure that mere ignorance would never have produced such delusions. The worst delusions are not the primitive ones, not the crude superstitions of a primitive people. The dogmas of an Ashantee rain-maker are harmless compared with those of a Spanish Inquisitor. We find priests and ignorance both in Ashantee and in Spain, but with this difference, that in Ashantee ignorance produces the priests, while in Spain the priests produce ignorance.

Henry Thomas Buckle holds that religions are influenced by the climate and topography of each country, and by the character of the inhabitants. "Barbarous creeds," says he, "are the result rather than the cause of a primitive stage of intellectual development. Superstition is merely the concomitant of the evils it seems to produce." The fallacy of the conclusion arises from the deficient specification of the premises; the logician overlooks the important difference between natural and factitious creeds; between local superstitions, produced by a process of natural development, like the customs and the language of a nation, and epidemic superstitions, engendered in the brain of a crazed visionary, and propagated by force and fanaticism. The former bear the marks of various national characteristics, the latter impress their own characteristics on each conquered nation. Natural superstitions reflected the poetical genius of the ancient Greeks and the warlike spirit of the Spanish Celts, but the national spirit of both Greece and Spain was crushed out by the dogmas of anti-naturalism. There are local superstitions that can not be exported; the myths of Brahmanism can not be separated from the physical geography of their East Indian habitat, while the *sagas* of the frost-giants and fur-clad hunter-gods could originate only in a frigid latitude. The Hindoo sticks to his rice, the Icelander to his whale-blubber. But poisons are more cosmopolitan: whisky and pessimism find votaries in every clime. The oldest creeds are the most harmless ones, for the superstitions of a primitive people are founded on natural impressions, which are not apt to mislead us to any dangerous degree. What harm could there be in the fancy of the Arcadian shepherd who heard a spirit-voice in the answering echo of his mountains, and ascribed the sudden stampede of his flock to the trick of a frolicsome faun? Bread-and-honey offerings to the fairies did not bankrupt the Hibernian peasant. Nearly all children of nature recognized the benevolent purpose in the gifts of the great All-Mother; the gods of antiquity were mostly helpful and beautiful spirits, while the nature-hating creed of the middle ages peopled the world with legions of hideous demons. The first May-night, when Hertha awakens the slumbering wood-spirits, became the *Walpurgis Nacht*, with its hellish revival-meetings. The satyrs became mountain-devils; St. Irenæus intimates that Jupiter Olympius was the disguised arch-fiend in person, the chief of evil spirits—nay, Ritter Tannhäuser does not hesitate to denounce the Goddess of Beauty to her face: "Frau Venus, schöne Gattin mein, Ihr seid eine Teufelinne" ("My lady, ye are a female devil"). The pantheon of the Mediterranean nations became a pandemonium, and in all Christian countries of mediæval Europe this devil-mania raged with a uniformity of violence and persistence that completely refutes Buckle's theory. From the fourth to the end of the fifteenth century fanaticism was clearly not the result but the cause of ignorance. The dogma of unnaturalism raged like a pandemic disease, and the changes it suffered in its progress from Asia to Spain are altogether trifling compared with those it produced. Its influence leveled all national distinctions; it emasculated the valiant Visigoth and completed the degradation of the degenerate Byzantine; it increased the superstitions of Abyssinia and perverted the learning of Western Europe.

The works of Bodin, Sprenger, and Robert Burton furnish astounding proofs of what an amount of learning is compatible with the most extravagant superstitions. They were all three earnest lovers of Truth for her own sake—had accumulated stores of erudition that would break the intellectual backbone of a modern scholar; they were logicians of inexorable exactitude, but the very profoundness of their conclusions only reveals the bottomless absurdity of their premises.

Dr. Sprenger does not condescend to examine the reality of diabolical apparitions and infernal *liaisons*—it would be mere waste of time, he says, to discuss such well-proved facts—but applies the power of his logic to such questions as the following: If the offspring of a male devil and a human female can, by a proper course of penance, efface the stigma of his birth, can he be intrusted with the responsibilities of a municipal or subaltern clerical office? And, in case he should succeed in concealing his parentage and obtain ecclesiastical preferment, should not a conscientious diffidence at least inspire him to plead a *noli episcopari?* And if, by any chance, his—progenitor should appear to him, is he bound to treat the old gentleman with anything like filial respect? would he be obliged to exorcise his own father? or how could he compromise the difficulty? And what if he should find that he has inherited the paternal talent for magic arts, and can not rid himself of the fatal bequest—does the welfare of his soul require that he should denounce himself to the proper authorities? Persistent good luck, success in vaticination, etc., might be regarded as mere presumptive evidence, but if a Christian finds that he can fly, it would be a very suspicious circumstance; would he be justified in exercising his gift for worthy purposes—take a flit to Loretto, for instance, or should he fly straight to the king's attorney, and thus prove both his guilt and his contrition? Or if, by prayer and fasting, he should hope to disqualify himself for such exploits, would it be right to give himself the benefit of the doubt? An orthodox Catholic had better strictly abstain from volitation, but if such scruples were to seize him in mid-air, would it be advisable for him to let himself drop? The gift of prescience would also embarrass a man in that predicament—would it be right to conceal his foreknowledge if, by a timely hint, he could avert a public calamity? Reticence would, on the whole, be the safest plan. But should a man abstain from marriage, lest his wife might be less discreet? Persons troubled with a burdensome secret are apt to talk in their sleep.

Jean Bodine quotes St. Augustine to the effect that a certain Præstantius confided to him an adventure of his father's, who, having been drugged by a witch, was transformed into a horse, and had to carry a load of corn ("*De Civitate Dei,*" xviii, 18). Such transformations, says Bodine, are still of daily occurrence, and only a false modesty prevents the victims from achieving the glory of exposing the enchanter.

Witches, it is well known, can change only the body, but not the soul, of a fellow-creature; the corn-carrying contemporary of St. Augustine was doubtless conscious of his degradation, and no horse of proper principles should hesitate, under such circumstances, to gallop away and state his case to the next exorcist. In Northern Germany, metamorphoses of that kind are especially frequent, the object of the wizards being to secure a mount on their way to the Blocksberg, and, though individuals have no jurisdiction in such matters, Monsieur Bodine would advise the anthropohippos to watch his opportunity and disable his rider by a well-aimed kick. Two gamekeepers of the Duke of Brunswick, both men of unimpeachable veracity, once saw a whole cavalcade of Walpurgis-riders, but hesitated to shoot for fear of hitting a hack instead of a hag. In the same duchy a witch *in tormentis* once revealed a sentence that would horsify a man in a minute, but Monsieur Bodine is happy to state that he has forgotten the formula. To remember such things is highly dangerous. One judge of the Criminal Court of Lorraine had cross-examined so many witches that he at last began to suspect himself, and, having dropped a hint to that effect, was seized and burned with the proper rites.

With the exception of Ibn Chaldir, who passed nine tenths of his long life in a public library, Robert Burton, the vicar of Segrave, was probably the best-read man who ever lived. He had studied philology, philosophy, theology, law, and medicine; he was a first-class mathematician, a zealous astronomer, and "calculator of nativities"; he had read nearly every volume in the Bodleian collection and in the library of Christ-Church College. He was well versed in the philosophical speculations of the mediæval school-men. He had mastered the inductive system of his great contemporary. All this learning did not prevent him from perpetrating the following dicta:

"The air is not so full of flies in summer as it is at all times of invisible devils. . . . Fiery devils are such as commonly work by blazing stars, fire-drakes, or *ignes fatui* (which lead men often *in flumina aut præcipitia*), whom, if travelers wish to keep off, they must pronounce the name of God with a clear voice, or adore him with their faces in contact with the ground. . . . Aërial devils are such as keep quarters in the air, cause tempests, thunder and lightning, make it rain stones, wool, frogs, etc. . . . Subterranean devils are as common as the rest, and do as much harm. The last are conversant about the center of the earth, to torture the souls of damned men to the day of judgment; their egress and regress some suppose to be about Etna, Lipari, Terra del Fuego (!), etc., because many shrieks and fearful cries are continually heard thereabouts, and familiar apparitions of dead men, ghosts, and goblins. . . . The devil being a slender and incomprehensible spirit, can easily insinuate himself into human bodies. A nun did eat lettuce without grace, or signing it with the sign of the cross, and was instantly possessed. . . . A young maid called Katherine Galter, a cooper's daughter, had such strange passions and convulsions that three men could sometimes not hold her ; she purged a live eel, which suddenly vanished; she vomited *some twenty-four pounds of strange stuff of all colors, twice a day for fourteen days*, and after that she voided great balls of hair, pieces of wood, pigeon's dung, parchment, goose-dung, coals, and large stones. They could do no good on her with physic, and left her to the clergy. . . . The arts of witches are almost as infinite as the devil's, who is still ready to grant their desires, to oblige them the more unto him. They can cause tempests and storms, which is familiarly practiced by witches in Norway and Iceland, as I have proved (!). They can make friends enemies, and enemies friends by philters, *turpes amores conciliare*, enforce love, tell any man where his friends are, about what employed, though in the most remote places, and, if they will, bring their sweethearts to them by night, upon a goat's back flying in the air."—("Anatomy of Melancholy," Part I, section 2, subject i–iii.)

Neither learning nor logic afforded a safeguard against the monomania of the middle ages, and Northern Europe owed its final deliverance to the love of freedom rather than the love of science. The delusion of the fourteen hundred years' interregnum of reason was to all purposes a contagious mental disease ; and who shall say if the prophylactics of our present civilization afford a guarantee against the recurrence of such epidemics? In the mind of a mental pathologist the progress of spiritualism, with its revived thirst for miracles, might awaken unpleasant recollections of the second century—the eve of the era when St. Gregory Thaumaturgus carried the day against the protests of the Roman Huxleys and Carpenters. The trouble is, that the creed of science has thus far been always agnostic, and its negative propaganda could not maintain the field against the enthusiasm of a positive superstition. Faith strikes deeper roots than skepticism, and the dogmas that could crush out the logic of Aristotle found their match in some of the silliest myths of paganism. Several myths of this sort proved so wholly ineradicable that the new creed could assert its supremacy only by a kind of grafting process, a mythical metastasis that enabled the new dogma to draw its nourishment from the root of an old superstition. The period of many Catholic festivals coincides with the season of ancient Roman and Druidical mysteries. Sacred fanes became miraculous shrines ; Ceres, Bacchus, Venus, Pan, and Priapus still collect their old perquisites in the name of new saints.

Even popular traditions have thus been metamorphosed. In the mystic recluse of the Barbarossa legend, Professor Grimm recognized the All-father Wodan, whose attributes had been transferred to the person of Charlemagne, and afterward to Frederick Barbarossa. When the oaks of the sacred groves were felled for church-timber, the old Saxon god retired to the mountains, the usual refuge of exiled deities, and finally went to sleep in a mountain-cave, the Untersberg, near Salzburg, and the Kyfhäuser in Northern Germany, where he awaits the return of better times, the resurrection of the buried nature-worship and the departure of the black crows, the clerical birds of ill-omen that fly croaking around his rocky retreat. The prototypes of these croakers did not relish the legend, and managed to substitute a secular hero, and in another case even a spook. The Wild Huntsman was originally a Welt-jäger, a *world-hunter*, the old sport-loving wood-god, with his hounds and falcons and train of merry companions. In Western Pomerania the leader of the nocturnal chase appears under the semi-*incognito* of a Junker *Hakelberg*, the "cowl-bearer"—another cognomen of the mist-shrouded Odin.

Sir William Jones's researches into the sacred writings of Brahmanism revealed a still stranger metempsychosis of myths—the transfer of the primeval Krishna legend to the personal history of Buddha Sakya-Muni, and its subsequent exportation to a far Western colony of Buddhism. According to Maurice's translation of the Bhagavat Purana, Krishna (like Buddha) was a Parthenogenitus, a virgin-son. The birth of both Krishna and Buddha was foretold by a heavenly messenger. Both were of royal descent. The delivery of the virgin-mothers was attended by the same prodigies, the rising of a new star and the appearance of a company of heavenly choristers. Three Eastern monarchs visited the new-born infant. Cansa, the ruler of Krishna's birth-land, ordered a massacre of young children in order to prevent the fulfillment of an ominous prophecy. Both Krishna and Buddha passed several years in exile before they entered upon their mission of reform. Krishna, like Buddha, had twelve favorite converts, who accompanied him on his missionary travels. *Cætera, qui nescit?*

Our very hobgoblins are of Eastern origin; nearly all international fairy-stories and popular traditions have their roots in the fruitful myth-garden of Hindostan. The stories of Cinderella, of Tamerlane, and Jack the Giant-killer, amused the children of Sind before Nimrod built his great adobe palace; William Tell learned his trade in the archer brigade of a Nepaulese tyrant; and the fair Melusina used to bathe in the Ganges before she built her swimming-hall in the castle of Poitiers.

Of the Melusina legend a modern French evolutionist (M. de Lescure) gives the following curious exegesis: "The discovery of the Marquis of Poitiers, which resulted in the dissolution of his connubial tie, may yet lead to other divorces if the allies of the orthodox cosmogony should take a peep through a certain key-hole. The allegory reveals the great *arcanum* of nature, the secret, namely, that the human shape divine has been evolved from the form of a fish."

[*To be concluded.*]

METHODS IN MODERN PHYSICAL ASTRONOMY.*

By M. JULES C. JANSSEN.

It has become an almost consecrated custom for the President of this Association, instead of relating the progress which has been made in all the sciences that are the objects of your investigations, to treat more particularly of a single one of them, and to present a summary of the progress it has made. This custom appears an excellent one to me. By it we gain in precision and authority what we lose in extensiveness; and we owe to it many masterly efforts, the impression of which has not yet been effaced from our minds, and which cause in me a just apprehension that I may fall far short of their standard.

I shall endeavor to present to you a picture, sketched in broad outline, of the progress and influence of a branch of research which has played a considerable part in contemporary scientific movements, and the discoveries of which have not only revolutionized our astronomical knowledge, but have also opened new and unexpected horizons to philosophy—I mean physical astronomy.

Physical astronomy is a wholly modern—yes, as to its best parts, contemporary—science; and it can be regarded as old only as concerning its object. From the earliest times, in fact, that men began to look toward the sky, and the first reflections on nature were born of these first observations, man has asked what is that sun whose immense and beneficent function caused it to be designated at that early period as the soul of nature. He has asked himself what is the cause which lends to the moon the sweet and mysterious light that gives to the nights so poetical a charm; and afterward questions arose concerning those brilliant points with which the celestial vault is strewed. All these problems appertain to our science, but how little was man then in a condition to deal with them! Long ages of observations and labor were necessary before even the corner of the veil could be raised.

This was because physical astronomy presupposes a very clear knowledge of the properties of light, both as to itself and as to its relations with bodies, and great perfection in the mechanical arts to

* President's address at the French Association for the Advancement of Science, La Rochelle, August, 1882.

permit the construction of the apparatus, at once extensive and delicate, which it employs.

Astronomy as a description of motions, on the contrary, only required the eyes and very simple instruments. Therefore the first astronomers began with that branch. At a later period, the science, ceasing to be purely descriptive, became geometric, and at last took a sublime flight; and by the application of the higher calculus we had the celestial mechanics.

During this long period, the physical branch of the science, to speak correctly, did not exist. Reduced to hypotheses that could not be verified, the theories of celestial physics had even fallen into discredit. It should be said that the beauty and importance of the discoveries with which the geometricians endowed the elder sister of our branch contributed no little to this result. Three great discoveries have, however, completely changed the situation, by giving to the physical branch arms which permit it at last to enter gloriously into the competition. I refer to the telescope, spectrum analysis, and photography.

The foundations of physical astronomy were laid in the invention of the telescope. Every one has heard of the emotion which filled Europe at the announcement of the discovery of an instrument which had the power of making distant objects appear as if they were near. It was at that time that Galileo, having only learned that such an instrument existed, discovered its arrangement, constructed one, turned it toward the sky, and, with this aid, fertilized by his genius, made a series of magisterial discoveries. These discoveries belong pre-eminently to physical astronomy, and form its first courses. If we except the sun and moon, which have a very sensible diameter, and admit of some observations without the aid of the telescope, all the stars appear to the eye only as brilliant points, and admit of no studies except of their motions. Therefore, an astronomy without the telescope would never have permitted us otherwise than as a matter of probability to consider the planets as like the earth in form, constitution, and office. But when it was seen that these brilliant and almost blazing points were resolved under the telescope into well-defined disks, showing indications of continents, clouds, and atmospheres; when satellites were perceived around those globes playing the same part to them as the moon plays to the earth—then probabilities gave place to a clear certainty. Telescopes, then, are the instruments by means of which the constitution of the solar system has been definitively unveiled, and the earth has been assigned its part and its rank in the system of the planets. The discovery of the spots on the sun and of its rotation completed the conception of the solar system and prepared for the theory of its formation. Here is marked a well-determined phase in the history of human ideas respecting the universe, and it is characterized by the great name of Galileo.

Was it possible at once to go beyond this? Was it possible to question the stars in their turn, and inquire if, like the sun, they had a sensible disk, spots, a rotation, and planets revolving around them; was it possible, in short, to extend to the stellar universe the notions we had already acquired concerning the solar system? The methods in use did not yet permit this.

The most delicate measurement of parallaxes has proved that the star nearest to us is two hundred thousand times as far off as we are from the sun. We should, then, need a telescope magnifying more than two hundred thousand times to show us, under the most favorable circumstances, a star's diameter equal to that which the sun presents to the naked eye. Such a power is a hundred times greater than the strongest powers that can be used. We are, therefore, obliged to stay within the limits of our system, and proceed by analogy when we desire to go out of it. The analogies, it is true, were very powerful means even with Copernicus and Galileo, but with Kirchhoff and Huggins they were destined to acquire very shortly an irresistible force. Nature habitually reserves for the assiduous and sagacious observer surprises that exceed his hopes. So, while the study of the stars, considered as individual worlds, still remained beyond our reach, a great observer discovered facts of a very general bearing.

This leads us to a second phase of the period of telescopes—a phase that was characterized by the observations of the great Herschel. Herschel changed the form of the instrument, and adopted one that was more adaptable to the realization of the great powers he sought to obtain. Then, by his magnificent studies of the nebulæ, and by his discovery of multiple stars revolving around one another, he laid the foundations of the theory of worlds with multiple centers. This was a new conception, which did not proceed from that of the solar system, but was much more general. The problem was thus resolved in its extreme terms; but between these extremes yawned an immense gap.

The gap has not yet been filled. We can not directly study those worlds which each star forms with the planets of its suite, but a new method of investigation has come forward to shed unexpected light on the unanswered questions.

The first period of physical astronomy was opened with the modest telescope of Galileo, and closed with the large telescopes of Herschel. As early as the beginning of this century, when the astronomer of Slough had finished his review of the sky, it was felt that the telescopic harvest was nearly gathered, and another instrument of progress was looked for. Arago thought he had found it in the discovery of Malus, to which he made brilliant additions, and earnestly endeavored to found a new branch of physical astronomy on polarization. He was not successful. His discoveries ceased after a few beautiful applications of his method. At this time the polariscope process is only employed to determine whether light is reflected or emitted.

Quite different was it with a method the origin of which, we believe, goes back to the very birth of optics. This method is likewise founded on the actions of bodies on light, but, so rich and profound are the modifications with which it has to deal, that it has been able to pass over that in the matter which concerns only its general properties, and look into its peculiar individuality, its specific chemical quality. The principle which is the basis of the new method of spectrum analysis is as simple as general, and may be stated by saying that the elementary rays emitted by every kind of radiating gasiform matter depend upon and characterize the chemical species to which that matter belongs. Hence it follows that the spectral image resulting from the analysis of the beam of rays emitted by any body will vary according to the chemical nature of that body. Spectum analysis is founded upon the examination of spectra.

It must be added that the chemical nature of a body is not the exclusive element in the constitution of its spectrum, but that that may vary with the physical circumstances of the phenomenon, the temperature, the cause generating the radiation, etc. ; but these are subordinate effects, which only add to the richness of the method, without detracting from its certainty and its value.

We have been able to leap over the enormous distance which separates the conception of the body, viewed as to its general properties, from the notion of it as individualized in such a manner as to constitute a chemical species by regarding light not only as a whole, but also in its elementary parts ; by not only studying the whole beam and the general modifications that affect it, but by extending the examination to the elementary rays of which it is composed. The little mass of matter forming the chemical molecule, when it can vibrate freely, as in the gaseous state, emits a peculiar system of waves, a system which varies principally with the chemical species of the molecule, but which varies also, though rather secondarily, with the distance apart of the molecules and the nature and intensity of the forces that induce a vibratory movement in it. We might illustrate the nature of the system of luminous rays emitted by such a molecule by comparing it to the system of sounds given off by a vibrating cord, which is dependent for the principal characteristic on the length of the cord, and for the secondary phenomena of volume, tone, etc., on other circumstances accompanying the vibration.

It is proper to remark at this point that, when we analyze light in this way to examine it in its elements, we perform an operation entirely parallel to that of the chemist who separates the simple elements of a compound body. The elementary ray is a chemical species in light. It has all the characteristics of a species. It is incapable of decomposition, it has an individuality of its own, characterized by its wave-length, by the physiological effects it induces, whether acting alone or in association with other rays, and by the phenomena which it exhibits in its relations with bodies. We then bring the two sciences together by performing on light an operation parallel to the one that has been made on matter. Chemical analysis by light was performed *in posse* on the day when its rays were regarded in the light of chemical species.

This great idea of the specific character of luminous rays is due to Newton. It was introduced into science when that great genius gave his explanation of the action of the prism on white light. The foundations of spectrum analysis were laid at that time, and the study of it might have been begun then at once; but the human mind does not proceed with so penetrating and absolute a logic as that. The successive and often fortuitous acquisition of revealing facts had to be left to time. It must, however, be said that, when the facts were presented, their real significance would have been overlooked, notwithstanding the genius of the experimenters, had not the grand idea of Newton illuminated them with its brilliant light. The conception of the individuality of the rays made its way so slowly into our minds that it bore its fruits, as it were, unknown to us. But history, whose vision goes back to the beginnings, will have to assign their respective parts to the causes which have been influential toward the end. The allotment will in no degree diminish the admiration which is due to the creators of the marvelous instrument. They have given a body of life to what was slumbering *in posse;* they have thus shown themselves worthy continuers of the work of Newton.

You know that this spectrum analysis made its appearance very suddenly in science. You may recollect the emotion that affected us all when it was announced that the solar atmosphere had been chemically analyzed, and a list of the metals it contained was published. You are, however, too well acquainted with the history of science to suppose that a method as complete as the one that was thus announced had no antecedents. The antecedents in fact existed, and they were even numerous. With the labors which contributed to the constitution of the definitive method were associated the names of Sir John Herschel, Talbot, Miller, Wheatstone, Swan, Masson, Foucault, etc.; but Kirchhoff and Bunsen were able to make a synthesis of all these efforts, and they gave the method its general and practical form. When spectrum analysis presented itself to the scientific world, it held in one hand cæsium and rubidium and in the other hand a list of the metals recognized in a star ninety-three million miles away. Why, then, should we be surprised at the enthusiastic reception that was given it?

At first it was believed that the incandescence of gases was one of the conditions of elective absorption by them. A French physicist, judging that the phenomenon related rather to the gaseous condition than to the temperature, was led to believe that the earth's atmosphere, as well as the atmosphere which was supposed to exist around the sun, might exercise such an action; and he showed that the solar spectrum contained a whole system of dark and fine lines, comparable to the lines of solar origin, but which were due to the action of our atmosphere. Brewster had already discovered that the solar spectrum was enriched with dark bands at sunrise and sunset, but that in his instrument they wholly disappeared during the day. Both Brewster and Gladstone, his eminent co-laborer, declared in their last memoir on this subject, in 1860, that they could not determine the cause of the phenomenon.

The absorbing action of our atmosphere was still more plainly demonstrated by an experiment on the Lake of Geneva, in which the absorption rays were obtained with the light of a fire passing over Lake Leman, from a distance of fourteen miles. It was also shown in an experiment made at Villette, with a tube filled with vapor at seven atmospheres of pressure and one hundred and twenty feet long, that the vapor of water has a complete absorption spectrum, and that the largest proportion of the absorption phenomena of our atmosphere should be attributed to it.

These observations and experiments doubled the field of investigation opened to spectrum analysis. Not only could the incandescent atmospheres of the sun and the stars now be made to reveal their nature and their composition to us, but our researches might also be extended to objects having a still greater interest for us. We could at once take our own atmosphere for an object, investigating high and inaccessible regions, and making analyses in them which could not be attempted by any other means. Then, going away from the earth, we could interrogate the planetary atmospheres, and seek in them the vapor of water, and with it one of the first conditions of the development of terrestrial life. We could also, comparing the composition of the planetary atmospheres with the astronomical facts which permit us to judge of the geological conditions of the surfaces of the planets, follow in them the atmospheric evolutions which on the earth belong to the domain of the past or of the future. Finally, the same study of the planetary atmospheres, when it shall have become more complete, will show us whether our atmosphere is a type reproduced everywhere, the composition of which appears from that fact indispensable to the existence of living beings, or whether, discovering atmospheres of varied compositions, we shall be led to suppose that life may appear and be developed in media essentially different. The planetary stars are not, however, the only ones that lend themselves to these applications. There are also fixed stars the spectra of which reveal the characteristics of the vapor of water. Now, we know that the atmosphere of a star must be considerably cooled to permit the gases of which water is constituted to combine and generate a vapor. Our sun is still very far from this critical condition. It is also remarkable that the stars presenting these characteristics are generally red or yellow ones. In this manner the spectroscope may help us to estimate in some degree the age of a sun, and measure the length of the career which it has already accomplished.

While studies of this kind were going on in France, spectrum analysis was receiving magnificent developments in England, more in the line which its authors had indicated. Messrs. Miller and Huggins entered upon the study of the stars, and found in all of them which they examined the solar elements in various combinations. This discovery had an immense philosophical bearing, for it proved that the matter forming the solar and the stellar world is obtained from the same elements. It was a demonstration of the material unity of the universe. The study was prosecuted still further. There are stars which we regard as situated on the confines of the visible universe, the light of which is so weakened by the immense journey it has to make to reach us that they appear only as feeble glows. Mr. Huggins succeeded in analyzing some of them, and showed that there exists a whole class of nebulæ which are really unresolvable into stars, and are formed of incandescent gases, among which hydrogen, which thus seems to be the principal element in the composition of the universe, is the most prominent.

So the whole visible universe—not only our central star and the planets of our family, but those stars, too, which are so far off that our most powerful telescopes can not give them a sensible diameter, and those nebulæ which only make a weak glow in our instruments—is reached by our chemistry, seized by our analysis, and made to furnish the proof that all matter is one, and that these stars are made of the same stuff as we. More, still, than this: at those great distances, and in the presence of the vague and indefinite forms of the nebulæ, it would not be possible to study precise movements and discover whether the great law of gravitation reigns in such remote regions. Chemistry here comes to the aid of mechanics, and we may say boldly that that matter, which is identical with ours, is subject, like it, to the laws of gravitation. Certainly, when Newton decomposed a beam of white light, and laid the first basis of the theory of the spectrum, he had not the slightest suspicion that his law of gravitation would, at a later period, find in it wings to carry it into regions where all measurement ceases and all calculation is powerless.

Spectrum analysis, after having in this manner, in a few years, gone through the universe and reaped the magnificent harvest I have just described, now returns to the sun, the point whence it departed, to take advantage of the opportunity afforded by eclipses. These phenomena, it is well known, exhibit a collection of magnificent spectacles of an extraordinary character, which had heretofore remained unexplained. Those rosy-colored protuberances of strange forms which surround the dark limb of the moon, that magnificent luminous corona, those radiances in the form of a glory and extending to enormous distances—all constituted so many riddles for astronomers till 1868. In that year one of the great eclipses of the sun took place. We might say that, at the very moment when the heavens had just suffered their most precious secrets to be revealed, the star of day had deigned to invite us to the study of his admirable structure.

The eclipse was observed, and the result surpassed even the general expectation. The nature of the protuberances was immediately recognized, and a method was discovered that permitted the study of these phenomena every day, without having to wait for the rare occasions of eclipses. This method led in a short time to the discovery of the chromospheric atmosphere, and this completed and explained the phenomena of the protuberances. The first results of the spectroscopic investigations may be stated thus :

The sun of Herschel and Arago, formed of a central nucleus and a luminous envelope, the photosphere, has an additional stratum formed chiefly of incandescent hydrogen. This stratum, in immediate contact with the photosphere, is very thin, being only from eight to ten seconds thick ; it is the seat of small eruptions of metallic vapors rising from the photosphere, in which sodium, magnesium, and calcium predominate. Frequently, however, principally at the time when the sun-spots become abundant, there rise from the solar globe formidable eruptions of hydrogen, which pass through this same envelope and rise to a height of sixty thousand or ninety thousand miles. These eruptions are the protuberances of the total eclipses, the nature of which is thus revealed and the forms explained.

The corona and the phenomena exterior to it were the objects of study in the next eclipses. In 1874 French observations showed that the corona constituted a new solar atmosphere, a very rare one and enormously extended, in which hydrogen still dominated, while it presented spectral conditions as yet unexplained. This atmosphere seemed to borrow a part of the appearances of the protuberance-eruptions which penetrate it and are extinguished in it. It also seemed probable, and that opinion was expressed by the author of these observations, that the figure of the corona would vary with the condition of external activity of the sun. At the times of the maximum of spots, when the protuberance-eruptions were in the highest activity, the coronal atmosphere would be intersected by numerous and rich jets which would increase its extent and density, and change its aspect. This opinion was confirmed by one of the observers of the last eclipse in Egypt.

I shall conclude this brief review of the methods of physical astronomy with a word upon an art which has recently brought a really wonderful aid to all our scientific studies—I mean photography. Considered in its old and primary object, the aim of photography is to fix the images of the *camera-obscura*. Its aim, however, and its means have been singularly extended. We have to consider here only the aid and the applications which physical astronomy can expect from it.

The first application which was made of photography to the study of the sky was in France, whatever may be said about it. The first image of a fixed star upon the daguerrean plate was that of the sun, and it was taken by the authors of the admirable processes for measuring upon the earth the velocity of light—MM. Fizeau and Foucault. Shortly afterward, images of the moon were obtained in the United States. These labors were followed by others, of which the sun and the moon were also the objects. Beautiful proofs of lunar photographs have been taken by Mr. Warren de La Rue and Mr. Rutherfurd. Photographs of the sun are taken regularly in many observatories, as aids in the study of the spots and faculæ of that star. More recently, Mr. Rutherfurd and Mr. Gould have begun to make celestial maps, and photographs of the nebula in Orion have been obtained in New York (by Mr. Draper) and at Meudon.

These works are all very important; they bear upon the primary object of astronomical photography, that of obtaining durable and trustworthy images of the stars and the phenomena produced upon them, available for further studies and measurements. Hitherto, observers had only memory, a written description, or a drawing, to depend upon for the preservation of the recollection of a phenomenon. Photography substitutes for this the material image of the phenomenon itself. It is an admirable artifice, which in a certain manner prevents the extinction of the phenomenon and its passage to among the things that were, and keeps it always with us for examination or study. Important as these results may be, the latest labors of which photography has been the object, especially in what concerns the sun, have demonstrated that the method may be employed as a means of making discoveries in astronomy.

The large solar images which have been obtained in the latest years at Meudon have revealed phenomena of the surface of the sun which our largest observatory instruments could not have shown, and which open a new field of studies. By their aid we can at last distinguish the real form of those elements of the photosphere, respecting which so many different and contradictory assertions have been made. The elements in question are composed of a fluid substance readily obedient to the action of external forces. At points of relative calm, the matter of the photosphere assumes forms more or less approaching the spherical, and its aspect is that of a general granulation. Wherever, on the other hand, currents and more violent movements of the matter prevail, the granular elements are more or less drawn out, and present aspects suggesting the forms of grains of rice, willow-leaves, or veritable threads. The regions, however, where the photosphere is more agitated, are limited spots, and the granular form is generally observed in the intervals between them. The result of this peculiar constitution is, that the surface of the sun presents the aspect of a net-work, the web of which is formed of strings of more or less regular grains, with here and there elongated bodies drawn out in all directions. An attentive study of these curious phenomena leads us to a very simple explanation of them.

The stratum of luminous matter to which the sun owes its power of radiation is, as we know, very thin. If this stratum was in a state of perfect equilibrium, the fluid matter of which it is constituted would form a continuous envelope around the nucleus of the sun ; and the granular elements being confounded together, the solar surface would have everywhere a uniform brightness. But the ascending currents, of which the eruptions of metallic vapors and the hydrogen-protuberances are evidences, rupture the fluid stratum which is tending to form at a great number of points. It is then broken up and divided into more or less considerable fragments. Wherever the perturbing forces leave the elements of the photosphere in a state of relative repose, they take a more or less pronounced globular form. At those points, on the other hand, which are the seats of ascending currents, these elements give evidence in their aspect of the violence of the actions to which they are subjected. Hence the variable forms of the elements of the photosphere, concerning which there has been so much discussion. Hence, also, the explanation of that net-work-like structure of the solar surface which has been revealed by photography.

These images also show the enormous difference between the luminous power of the elements of the photosphere and that of the medium in which they float, which seems quite dark by the side of them. A result of this constitution is, that the radiating power of the sun will be affected according to the number and brightness of these elements. The spots, then, can no longer be regarded as the principal element in the variations of the solar radiation ; a new factor, the action of which may be preponderant, must hereafter be added to them.

These photographs permit another study, which promises results of extreme importance—the study of the motions which the granular elements take on under the action of the forces that rumple the photosphere. For the study of these motions, successive images of the same point on the surface of the sun are taken at very brief intervals with the photographic revolver. A comparison of the images demonstrates that the matter of the photosphere is animated by movements of the violence of which our terrestrial phenomena can convey only a very feeble idea.

Following the example of spectrum analysis, photography is making a circuit of the heavens. The year 1881 witnessed the first taking of the photograph of a comet, with a considerable portion of its tail. This picture has revealed some curious particulars of structure and has permitted a number of photometric measurements, the most notable of which is one showing that the tail, notwithstanding the brightness with which it appears to shine, is, at only a few degrees from the nucleus, two or three hundred times less luminous than the moon. There will doubtless be room enough to perfect these first efforts, for it will be of the highest importance to obtain by photography incontestable documents for the history of these stars, the nature of which still presents so many enigmas.

Equally interesting efforts have been made with respect to the nebulæ. Mr. Draper, in America, and the observatory at Meudon, have obtained photographs of the nebulæ in Orion. The nebulæ are of great importance in their bearing on the theory of the formation of stellar systems and the genesis of worlds. It would be immensely interesting to establish clearly the existence and the nature of changes going on in their structure, and good photographs of them would be valuable for this. They are, however, difficult subjects, on account of the extreme weakness of their light, the uncertainty of their outlines, and the variations of brightness in their different parts. Consequently, we are liable to have images of the same nebulæ, in no way comparable with each other, but varying according to the length of the exposure, the clearness of the sky, and the sensitiveness of the plate; and it becomes imperiously necessary to define the conditions under which the images are obtained.

The images of any object impressed by light upon the eye are fugacious, and can be of only a limited intensity. The images fixed upon the photographic plate are permanent, and can be made of an intensity that becomes cumulative with the duration of the exposure. The photographic retina may be expected, when the art has been perfected in the highest degree, to give us images corresponding with an extremely expanded range in the duration of the exposure. We now obtain photographic impressions of the sun in the one hundred thousandth part of a second, and can not yet guess what the final limit will be in the direction of brevity. On the other hand, the images of the comet required an hour, and that of the nebulæ in Orion more than three hours of luminous action. Thus the luminous action was more than five hundred million times as long in the last case as in the first. What phenomena can have wide enough ranges in brightness or obscurity to escape so admirable an elasticity?

The photographic plates, moreover, which are prepared now, are not only sensitive to all the elementary rays which excite the retina, but the power also extends into those ultra-violet regions and the opposite regions of dark heat in which the eye has no power.

The priceless advantages which photography offers for the prosecution of our experiments are, in short, the preservation of the images, the extension of sensibility, and the faculty of seizing phenomena of the most different degrees of illumination, including the extremely strong and the extremely weak.

The above is a very incomplete picture of what has been accomplished by physical astronomy. Is it not enough, however, to show that our branch of the science has already attained the height of its elder sister? Are not the two worthy of each other, and will they not be able to march hereafter at an equal pace to the conquest of the heavens? On one side we behold the calculus—that marvelous intellectual lever, putting the data of observation to work, and drawing from them magnificent and unexpected consequences. On the other side, that wonderful apparatus which analyzes light as if it were matter, which forces it to give images of near and distant objects alike, and, seizing the fugitive images, makes them fixed and durable.

Behold on one side, again, the mathematical genius that has created the analysis of the infinite, a genius of exactness and thoroughness, which is able to enter into all the elements of a question and disengage from the complication of data the ultimate consequences signified by them. On the other side, the genius of observation, which now watches phenomena with the innate and superior sense that enables it to discover their intimate relations, now questions Nature and carries on its experiments as the geometrician carries on his analysis when he wishes to prove or discover something, and now, illuminated by a sudden inspiration, makes at a stroke one of those approaches that open immense horizons.

On one side behold, finally, the heavens measured, the solar world placed in the balance, and its movements so well linked together by the law that governs them that soon, perhaps, past, present, and future will no longer exist for astronomy. On the other side, wonders still more astonishing: stars revealing to us their forms and the most minute details of their structure, as if they had left the depths of space to offer themselves submissively to our study; worlds intrusting the secrets of the matter that engenders them to the rays which they send us; and the history of the sky written by the sky itself. Finally, by the united efforts of the two, the entire universe, in its majesty and its grandeur, become the intellectual domain of man.

EVOLUTION OF THE STETHOSCOPE.

By SAMUEL WILKS, M. D., F. R. S.,

PHYSICIAN AND LECTURER ON MEDICINE, GUY'S HOSPITAL.

INSTEAD of placing on the table every imaginary form of stethoscope manufactured out of every possible material gathered from the shops of the instrument-makers, I will carry you back to the origin of the stethoscope, and you will see how, on the principle of selection and the survival of the fittest, the primitive instruments have departed from the scene and are now only to be found among the fossilized curiosities, the relics of former ages, on the antiquated shelves of some very old medical practitioner. The stethoscope, as you know, was invented by Laennec. He relates how in the year 1816 he happened to recollect a well-known fact in acoustics of solid bodies conveying sound, and he goes on to say: "Immediately on this suggestion I rolled a quire of paper into a kind of cylinder and applied one end of it to the region of the heart and the other to my ear, and was not a little surprised and pleased to find that I could thereby perceive the action of the heart in a manner much more clear than by the application of the ear. . . . The first instrument which I used was a cylinder of paper formed of three quires completely rolled together and kept in shape by paste." Laennec then goes on to describe how he copied this roll of paper in wood, metals, glass, and other substances, and finally he says: "In consequence of these various experiments I now employ a cylinder of wood an inch and a half in diameter and a foot long, perforated longitudinally by a bore three lines wide and hollowed out into a funnel-shape to the depth of an inch and a half at one of its extremities. It is divided into two portions, partly for the convenience of carriage and partly to permit its being used of half the usual length. The instrument in this form—that is, with the funnel-shaped extremity—is used in exploring the respiration and rattle; when applied to the exploration of the heart and the voice, it is converted into a simple tube with thick sides, by inserting into its excavated extremity a stopper or plug traversed by a small aperture and accurately adjusted to the excavation. This instrument I have denominated the *stethoscope*."

Fig. 1 represents Laennec's roll of paper, and Figs. 2 and 3 the copy of this in wood as he describes. The latter figure is drawn from an instrument kindly given me by Dr. Galton, of Norwood, being the stethoscope long used by his father. It does not separate into two

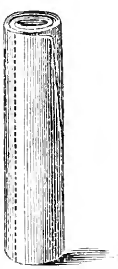
Fig. 1.

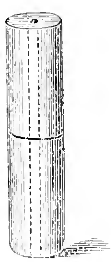
Fig. 2.

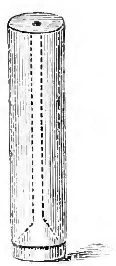
Fig. 3.

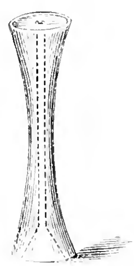
Fig. 4.


Fig. 5.

pieces, but contains the plug which can be removed so as to leave the end hollow. Fig. 4 is the same instrument with the sides cut out to make it lighter and more elegant, the ear-piece being the same as before, and the mouth also hollowed out. This was the stethoscope used and recommended by the late Dr. Hughes. By making the instrument still more elegant and slender we have the modern stethoscope in endless variety, as in Fig. 5. It is thus very evident how the modern instrument has been framed out of the original block of wood which was made the counterpart of Laennec's roll of paper.

I know not who invented the instruments with flexible tubes, but I have no doubt that a search into medical history could tell us. I remember, however, that the first flexible stethoscope which I ever saw was the one depicted in Fig. 6, and used by Dr. Golding Bird when he saw out-patients in the year 1843. Being much crippled with rheumatism, and therefore not wishing to rise from his chair, he found

Fig. 6.

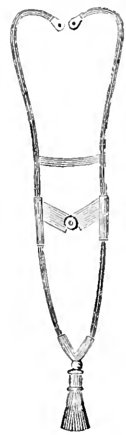

Fig. 7.

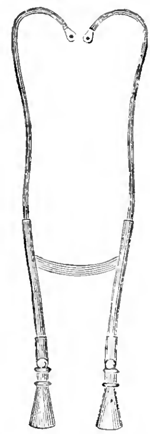

Fig. 8.

this instrument very convenient; he also was enabled to pass the ear-piece to gentlemen standing near him, while he held the cup on the part to be examined. I always thought it was his own invention. But, whether so or not, I do not think any great effort of genius was required to frame a flexible instrument, and then adapt it for the use of one or two ears. This being done, the next step would be to make two mouth-pieces to apply to the chest at different spots. Various modifications of these instruments have been made of late years, but the first notice of them I have any knowledge of in my reading is to be found in a letter to the "Lancet" of August 29, 1829, by Mr. Comins, of Edinburgh, headed "A Flexible Stethoscope." This was only twelve years after Laennec's invention. It is difficult from his description to picture the instrument, but it seems to have been composed of jointed tubes, and made for two ears as well as one. Mr. Comins expresses his surprise that the discoverer of mediate auscultation did not suggest a flexible instrument, as he says "it can be used in the highest ranks of society without offending fastidious delicacy."

A very interesting fact was first pointed out to me by Dr. Andrew Clark, with respect to a peculiarity of the binaural in the objective appreciation of sounds; that if each ear-piece be separately used, and any sound be made near the mouth-piece, it is heard in the ear itself, but, if the two pieces are employed together, the sound is heard at the spot where it is produced. The fact is very interesting in a physiological point of view, and further corroborates the theory as to the value of a double set of senses, or, in a word, of the body being made up of two halves, for just as the two hands feeling different parts of an object gain an idea of extension, and the two eyes by obtaining different views of any substance get a knowledge of its solidity, so in the same way the two ears listening to the same sound more thoroughly appreciate its objectivity.

If you look at this series of drawings you may perceive but little resemblance between the first figure and the last, but take them one by one and you will see that the figures are really progressive. My story of development is not imaginary, but historical.—*Lancet.*

SOCIAL FORCES IN AMERICAN LIFE.*

By HERBERT SPENCER.

A FEW words may fitly be added respecting the causes of this over-activity in American life—causes which may be identified as having in recent times partially operated among ourselves, and as having wrought kindred, though less marked, effects. It is the more worth while to trace the genesis of this undue absorption of the energies in work, since it well serves to illustrate the general truth which should be ever present to all legislators and politicians, that the indirect and unforeseen results of any cause affecting a society are frequently, if not habitually, greater and more important than the direct and foreseen results.

This high pressure under which Americans exist, and which is most intense in places like Chicago, where the prosperity and rate of growth are greatest, is seen by many intelligent Americans themselves to be an indirect result of their free institutions and the absence of those class-distinctions and restraints existing in older communities. A society in which the man who dies a millionaire is so often one who commenced life in poverty, and in which (to paraphrase a French saying concerning the soldier) every news-boy carries a president's seal in his bag, is, by consequence, a society in which all are subject to a stress of competition for wealth and honor, greater than can exist in a society whose members are nearly all prevented from rising out of the ranks in which they were born, and have but remote possibilities of acquiring fortunes. In those European societies which have in great meas-

* Remarks appended to Spencer's address at the New York banquet, reprinted in the "Contemporary Review."

are preserved their old types of structure (as in our own society up to the time when the great development of industrialism began to open ever-multiplying careers for the producing and distributing classes) there is so little chance of overcoming the obstacles to any great rise in position or possession, that nearly all have to be content with their places: entertaining little or no thought of bettering themselves. A manifest concomitant is that, fulfilling, with such efficiency as a moderate competition requires, the daily tasks of their respective situations, the majority become habituated to making the best of such pleasures as their lot affords, during whatever leisure they get. But it is otherwise where an immense growth of trade multiplies greatly the chances of success to the enterprising; and still more is it otherwise where class-restrictions are partially removed or wholly absent. Not only are more energy and thought put into the time daily occupied in work, but the leisure comes to be trenched upon, either literally by abridgment, or else by anxieties concerning business. Clearly, the larger the number who, under such conditions, acquire property, or achieve higher positions, or both, the sharper is the spur to the rest. A raised standard of activity establishes itself and goes on rising. Public applause given to the successful, becoming in communities thus circumstanced the most familiar kind of public applause, increases continually the stimulus to action. The struggle grows more and more strenuous, and there comes an increasing dread of failure—a dread of being "left," as the Americans say: a significant word, since it is suggestive of a race in which, the harder any one runs, the harder others have to run to keep up with him—a word suggestive of that breathless haste with which each passes from a success gained to the pursuit of a further success. And, on contrasting the English of to-day with the English of a century ago, we may see how, in a considerable measure, the like causes have entailed here kindred results.

Even those who are not directly spurred on by this intensified struggle for wealth and honor are indirectly spurred on by it. For one of its effects is to raise the standard of living, and eventually to increase the average rate of expenditure for all. Partly for personal enjoyment, but much more for the display which brings admiration, those who acquire fortunes distinguish themselves by luxurious habits. The more numerous they become, the keener becomes the competition for that kind of public attention given to those who make themselves conspicuous by great expenditure. The competition spreads downward step by step, until, to be "respectable," those having relatively small means feel obliged to spend more on houses, furniture, dress, and food, and are obliged to work the harder to get the requisite larger income. This process of causation is manifest enough among ourselves; and it is still more manifest in America, where the extravagance in style of living is greater than here.

Thus, though it seems beyond doubt that the removal of all political and social barriers, and the giving to each man an unimpeded career, must be purely beneficial, yet there is, at first, a considerable set-off from the benefits. Among those who, in older communities, have by laborious lives gained distinction, some may be heard privately to confess that "the game is not worth the candle," and, when they hear of others who wish to tread in their steps, shake their heads and say, "If they only knew!" Without accepting in full so pessimistic an estimate of success, we must still say that very generally the cost of the candle deducts largely from the gain of the game. That which in these exceptional cases holds among ourselves holds more generally in America. An intensified life, which may be summed up as great labor, great profit, great expenditure, has for its concomitant a wear and tear which considerably diminishes in one direction the good gained in another. Added together, the daily strain through many hours and the anxieties occupying many other hours—the occupation of consciousness by feelings that are either indifferent or painful, leaving relatively little time for occupation of it by pleasurable feelings—tends to lower its level more than its level is raised by the gratifications of achievement and the accompanying benefits. So that it may, and in many cases does, result that diminished happiness goes along with increased prosperity. Unquestionably, as long as order is fairly maintained, that absence of political and social restraints which gives free scope to the struggles for profit and honor conduces greatly to material advance of the society—develops the industrial arts, extends and improves the business organizations, augments the wealth; but that it raises the value of individual life, as measured by the average state of its feeling, by no means follows. That it will do so eventually, is certain; but, that it does so now, seems, to say the least, very doubtful.

The truth is, that a society and its members act and react in such wise that while, on the one hand, the nature of the society is determined by the natures of its members, on the other hand, the activities of its members (and presently their natures) are re-determined by the needs of the society, as these alter: change in either entails change in the other. It is an obvious implication that, to a great extent, the life of a society so sways the wills of its members as to turn them to its ends. That which is manifest during the militant stage, when the social aggregate coerces its units into co-operation for defense, and sacrifices many of their lives for its corporate preservation, holds under another form during the industrial stage, as we at present know it. Though the co-operation of citizens is now voluntary instead of compulsory, yet the social forces impel them to achieve social ends while apparently achieving only their own ends. The man who, carrying out an invention, thinks only of private welfare to be thereby secured, is in far larger measure working for public welfare; instance the contrast between the fortune made by Watt and the wealth which the steam-engine has given to mankind. He who utilizes a new material, improves a method of production, or introduces a better way of carrying on business, and does this for the purpose of distancing competitors, gains for himself little compared with that which he gains for the community by facilitating the lives of all. Either unknowingly or in spite of themselves, Nature leads men by purely personal motives to fulfill her ends: Nature being one of our expressions for the Ultimate Cause of things, and the end, remote when not proximate, being the highest form of human life.

Hence no argument, however cogent, can be expected to produce much effect: only here and there one may be influenced. As in an actively militant stage of society it is impossible to make many believe that there is any glory preferable to that of killing enemies; so, where rapid material growth is going on, and affords unlimited scope for the energies of all, little can be done by insisting that life has higher uses than work and accumulation. While among the most powerful of feelings continue to be the desire for public applause and dread of public censure—while the anxiety to achieve distinction, now by conquering enemies, now by beating competitors, continues predominant—while the fear of public reprobation affects men more than the fear of divine vengeance (as witness the long survival of dueling in Christian societies)—this excess of work which ambition prompts seems likely to continue with but small qualification. The eagerness for the honor accorded to success, first in war and then in commerce, has been indispensable as a means to peopling the earth with the higher types of man, and the subjugation of its surface and its forces to human use. Ambition may fitly come to bear a smaller ratio to other motives, when the working out of these needs is approaching completeness; and when also, by consequence, the scope for satisfying ambition is diminishing. Those who draw the obvious corollaries from the doctine of evolution—those who believe that the process of modification upon modification which has brought life to its present height must raise it still higher, will anticipate that "the last infirmity of noble minds" will in the distant future slowly decrease. As the sphere for achievement becomes smaller, the desire for applause will lose that predominance which it now has. A better ideal of life may simultaneously come to prevail. When there is fully recognized the truth that moral beauty is higher than intellectual power—when the wish to be admired is in large measure replaced by the wish to be loved—that strife for distinction which the present phase of civilization shows us will be greatly moderated. Along with other benefits may then come a rational proportioning of work and relaxation; and the relative claims of to-day and to-morrow may be properly balanced.

THE FORMATION OF LUNAR CRATERS.

M. JULES BERGERON says, in a paper communicated to the French Academy of Sciences, and republished in "La Nature": "I have noticed that when gases or vapors pass through a mass having the consistency of paste, they leave behind them funnel-shaped holes. Struck by the analogy which these holes present with the craters of the moon, I have endeavored to reproduce the phenomena on a larger scale. To simplify my experiments as much as possible, I used alloys, melting at relatively low temperatures, taking first Wood's alloy, of seven parts of bismuth, two of cadmium, two of tin, and two of lead, which melts at about 158° Fahr. Having introduced into the mass, melted in the salt-water bath, a current of warm air by means of a tin pipe, I allowed it to cool slowly while the inflation of warm air was still continued. The ebullition which took place reached all the parts—which were beginning to solidify and form a pellicle—over a considerable surface; and there was formed before me a large circle, around which the edges gradually rose under the continued inflation, till it began to assume the appearance of a crater. At the same time, the metallic mass becoming thicker as the cooling went on, while it was still blown out by the air, could no longer drive the solid particles away from itself, and rose above the crater in such a way as to form a cone, which grew visibly more prominent. The crater also became more hollow, with its inner walls more inclined than the outer walls, and I had before me a formation strikingly analogous to the craters of the moon. The same phenomena were observed, whatever alloy I employed.

"Similar processes have possibly taken place on the moon. Instead of gas, the reliefs may have been produced by the vapors, which rose freely from the body while it was in a fluid state; but the superficial part of the planet being cooled much more rapidly than the interior, the latter, still fluid, continued to emit vapors after the surface had become quite thick. The vapors found their way along the superficial envelope, and came out only at particular points, where, doubtless, the process of solidification was least nearly accomplished. The vapors may subsequently have been condensed, or absorbed, by the substances constituting the rock of the moon.

"As my first experiments were made in a capsule, the objection might be made that the circular form of the crater was produced under the influence of the shape of the walls of the vessel. To obviate such criticism, I employed a rectangular basin, in which I melted an alloy of four parts of lead, four of tin, and one of bismuth. The phenomena were produced as in the former case; but I found that the aspect of the mass after the formation of the crater varied according to what metal was used. With Wood's alloy, which is very fusible, the projections that fell on the edge of the crater flowed away, and left no trace of their passage. With the second alloy the pro-

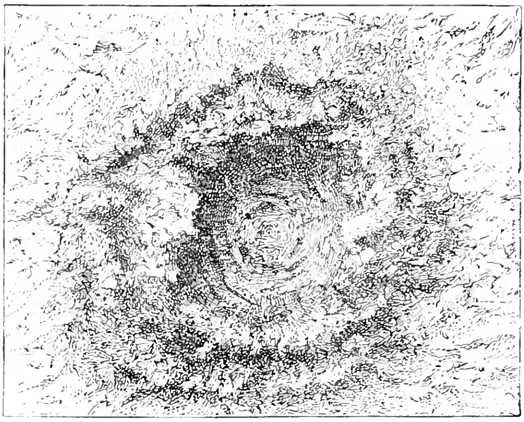

Fig. 1.—Artificial Crater obtained with an Alloy.

jections all continued visible, and gave a rent aspect to the crater. Moreover, since the warm air was not hot enough to melt the metal, the projections might eventually overhang the bottom, as appears in Fig. 1.

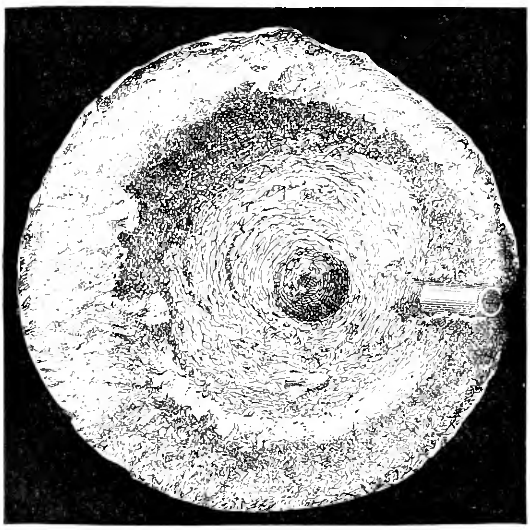

Fig. 2.—Action of a Current of Air on a Melted Alloy.

"The second experiment was marked by a very interesting incident. Two concentric circular areas were noticed, the one nearer to the center being the higher. This was due to an interruption to the passage of the air during the formation of the crater. The edges of Copernicus, Archimedes, and several other lunar craters are marked by analogous features.

"A formation like a dike appears to rise in the center of a considerable number of craters on the moon. I have been able to produce something analogous to this also, a representation of which is visible in Fig. 2. After I had ceased blowing in air, a last bubble was formed, which uplifted the mass, but could not project it above the edge of the crater. The lunar dikes are very probably formed in this way, by the action of the gas, at the end of the active period of the craters."

SCIENCE IN THE SICK-ROOM.

By CLARA S. WEEKS.

THERE is no subject of so much general interest as this, concerning which there is, at the same time, such a widely prevalent ignorance. There are few, especially among women, upon whom will not devolve, at some time in their lives, the care of the sick; fewer still who will not at some time become dependent upon such care; and it might naturally be supposed that matters of such primary and universal importance as sanitary conditions and the practical application in the sick-room of scientific principles would be too familiar to every one to need to be further enlarged upon. But the fact is, it too frequently happens that all the scientific knowledge which ever enters the sick-room comes in with the doctor and goes out again with him.

This state of things requires to be improved. Knowledge, and that correct knowledge we call science, is just as indispensable to the nurse as to anybody else. It is a great mistake to suppose that all women—even all good women—make good nurses. The best intentions and the tenderest heart may coexist with an utter lack of executive ability, and be more than counterbalanced by ignorance and prejudice. Native aptitude gives advantage, but it can not be relied upon alone. Even those who possess in the highest degree the natural gift of ministration which renders them so acceptable to the invalid would find their power of usefulness very largely increased by a familiarity with what may be properly called the science of the sick-room. Physicians are recognizing more and more the importance of hygienic agencies in the treatment of disease, and with this there has come an increasingly urgent call for the scientific instruction and practical training of those who are to take charge of invalids. Science explains the conditions upon which the art of the nurse depends, and lays down principles which can not be violated without injury; but it is not at all necessary to make a parade of technical language in stating its requirements. It is the object of the present article to furnish a few simple directions for the care of the sick that have the warrant of practical experience.

The first thing to be considered is the room itself. And the proper time to consider it is when you build your house. But, as most of us are forced to be content with houses already built, and built with no reference in the mind of the architect to the probability of illness among its inhabitants, it is only left for us to see how we may best avail ourselves of such conveniences—or inconveniences—as we may chance to have. There is always, at least, a choice of evils.

The sick-room should be on the sunny side of the house, and have plenty of windows. Only in exceptional cases, such as inflammation of the eye or brain, is it necessary to have the room darkened, and even then a south room, with the light carefully moderated by blinds and curtains, is to be preferred to a darker one on the north side. In the majority of cases, light, and not only light, but direct sunshine, is to be desired, not only for the additional cheerfulness which it gives, but because of its actual physical effects. Sunlight is a powerful remedial agent. You put the drooping plants which you wish to restore to vigor in the brightest, sunniest spot in your house—do the same with the feeble and sickly human being for whose improvement you are so anxiously looking, and you will derive similar beneficial results.

The sick-room should be, as far as possible, remote from the noises of the house and of the street. If, as is sometimes the case, this desideratum is quite incompatible with the last-named, still, except where there is great nervous irritability, give the preference to the sunny side, even at some loss of quiet.

Noise which is understood and inevitable is far less annoying than would be a much slighter noise, unexplained or unnecessary. Intermittent is more hurtful than continuous noise. Sudden, sharp, and jarring sounds are especially to be avoided. Manage, if possible, to have the room over your patient unoccupied. Modern houses are so slightly built, and their vibrations so trying, that, unless you can so arrange, you will often find it better to put your patient at the top of the house, in spite of the fatigue of the stairs.

Many slight and apparently unimportant noises, which are nevertheless peculiarly annoying to the sensitive nerves of the sick, may easily, with a little care and forethought, be entirely done away with. If you have coal to put on the fire, bring it in wrapped in a paper, and lay it on paper and all. Oil the hinges of creaking doors. Fix wedges in rattling windows. Keep rocking-chairs out of the room. Avoid wearing clothes that rustle or shoes that squeak. Do not whisper, either in your patient's room, or just outside his door. A low, distinct tone, when conversation is necessary, will seldom annoy. Whispering always will, as will any sound which creates strained attention or a sense of expectation. If you have anything to say which you do not wish your patient to hear, say it somewhere else than in his presence.

The first and greatest requisite in a sick-room is purity of air. This is only to be attained by constant and thorough ventilation. Ventilation is the displacement of impure by pure air. To secure this, there should be two apertures to the room, one for the egress of the foul air, and one for the admission of fresh air. The best possible arrangement is that of an open window and an open fire-place. If you do not wish a constant fire, keep a lamp burning at the mouth of the chimney to create a draught. Arrange a blind or screen so that the air will not blow directly upon your patient, and you may keep the window open day and night without danger of chilling him. Do not make the common mistake of confounding cold air with pure air. You may keep the room at any desired temperature, and still have the atmosphere perfectly fresh ; or you may lower the temperature to any extent without removing a particle of the poisonous impurities with which the air is laden. Keep your patient as warm by means of external appliances as his comfort demands, but never shut out the fresh air. Fresh air can only come from outside the house. Opening a door into a passage or an adjoining room, itself imperfectly aired, is not ventilation. Fresh air, may, however, be admitted to the sick-room through an adjoining apartment, first thoroughly ventilated. This is sometimes the best method of procedure. It requires, of course, more care to keep a small room well aired without objectionable draughts than a large one.

Stationary basins should never be used in the sick-room. The perfect system of house-drainage has yet to be invented, and the danger from leaky and defective traps is so great that the only safe way is to avoid them altogether. If you have such arrangements in the room which you propose to devote to your invalid, cork up the overflow-holes—or, better, stop them with plaster-of-Paris—and fill the basin with water, which must be changed from time to time, or cover it entirely with a board. The increased healthfulness of the atmosphere will more than compensate for the extra trouble which will be occasioned by adherence to this precautionary measure.

No cooking should ever be done in the sick-room. Neither should damp towels or articles of clothing be aired and dried there. All excreta should be promptly removed. Upon attention to these details depends that which should be the first care of every person in charge of the sick—that the air they breathe should be as pure as that outside.

The room, then, which we select for our invalid should be sunny, quiet, the one which affords the best facilities for ventilation and warmth, and without sewerage.

In the arrangement of the room, the same regard for the comfort and welfare of its occupant should be maintained.

The bed should be in the lightest part of the room, far enough removed from the wall to allow a free circulation of air around it, and to be easily accessible from both sides. It should be so situated that the patient can see out of the window. If you can give him a view from two windows, so much the better. Few people who have not experienced it can realize the weariness of mind which arises from long confinement to one set of surroundings. You have but to spend a few days in one room to become painfully familiar with every petty detail of its furnishing, and such variety as may be obtained from a glimpse out-of-doors will often afford an infinite relief.

It is frequently recommended that all superfluous and merely ornamental articles be removed from the sick-room, as useless incumbrances, only affording so many additional lodging-places for dust; but, unless you are dealing with contagious disease, you will find it better to spend a little more time in the removal of dust than to leave the sufferer with only the bare walls to gaze at, and nothing visible to vary the monotony of his thoughts. That a carpet or wall-paper of set pattern, or anything else presenting regularly recurrent figures, is objectionable, does not need to be suggested to any one who has ever been beset by the counting and classifying fiend who so often takes possession of the invalid left with no occupation for his vacant mind beyond such as is suggested by the objects within his limited field of vision.

Let the room be as cheerful as possible in its aspect. Flowers are quite permissible. Growing plants are better than cut flowers. The latter must be removed as soon as they cease to be perfectly fresh.

There should be no medicine-bottles or medical appurtenances of any kind in sight. They belong in the closet, and should be kept there, except when in actual use.

A thermometer is indispensable. Never permit yourself to judge the temperature of the room by your own sensations or by those of your patient. Hang the thermometer as nearly as possible in the center of the room—at all events, neither against a chimney in use or the outer wall. The one will be hotter and the other colder than the mean temperature, which is what you wish to have registered. This should be, unless you have contrary orders from the physician, about 68° Fahr.

The necessity for absolute cleanliness can not be too strenuously insisted upon. Dusting can only be efficiently done with a damp cloth. The ordinary methods in vogue simply serve to transfer the dust from one spot to another. Removal, not distribution, should be the object in view. The room can only be thoroughly swept and cleaned when the patient can be moved out of it for a time; but the dust may be removed from the carpet quite effectively and noiselessly by means of a damp cloth wrapped around a broom.

Not only for the sake of appearances, but from more directly hygienic considerations, are cleanliness and order to be regarded.

Upon the proper arrangement and care of the bed will largely depend your patient's comfort. This should be low and narrow enough for you easily to reach him from either side. The bedstead should be of iron or brass, with springs of woven wire, permeable by the air in every part. This is the only kind which you can be sure of keeping thoroughly clean. On this should be a hair mattress, never a feather bed. Make the under sheet as tight and smooth as possible, and take especial pains to keep it thoroughly dry and free from wrinkles, crumbs, and other inequalities. Neglect in this particular will give rise always to much discomfort and sometimes to serious troubles in the form of pressure-sores—which are extremely difficult to cure, but nearly always preventable by care. Very heavy or very much emaciated patients, and those suffering from affections of the brain, are particularly liable to these. It is often advisable, especially where a bed is prepared for long occupancy, to put next to the under sheet one of rubber, covered with a second folded sheet, or draw-sheet. This can be easily and frequently changed with but very slight disturbance to the patient. The bed-coverings should be such as are warm without being heavy, as their weight is often found oppressive. In some cases even slight pressure is unendurable. The weight of the clothes may then be supported by a wooden frame-work underneath.

All bedding should be frequently renewed, and always well aired and warmed before being used. If you have a patient entirely confined to bed, it will add greatly to his comfort if you can give him two beds, each provided with its own complement of sheets, blankets, etc. Let him occupy one during the day, and be transferred to the other for the night. If they are of equal height, this can be easily done, and the smooth, fresh condition of the unused bed will do more than any narcotic toward securing for him a good night's rest.

To prop a patient up with pillows, begin by slipping one as far down as possible against the small of the back. Put the next and succeeding ones each behind the last; this will prevent them from slipping. Aim to raise the head, and support the shoulders without throwing them forward so as to interfere with the free play of the lungs. Two or three small pillows, which can be moved from place to place as occasion requires, will be found of great service.

About the person of your patient, no less than about his room, labor to secure the most scrupulous cleanliness. Neglect of this too often arises from a fear that the patient will take cold; but it entails a greater risk than this to leave him in clothing saturated with morbid effluvia, and with the pores of his skin clogged by the noxious products of disease. No patient is ever too ill to be kept clean. If proper precautions are used and unnecessary exposure avoided, no danger need be apprehended.

The proper administration of food is often the great problem of the sick-room. There must be due regard to the kind, quality, and quantity, and to the time and manner of giving it. The kind of food to be given is usually prescribed by the physician. If it is left to your own discretion, consult, as far as possible, the tastes of your patient, try to secure a judicious variety, and do not let him know until you bring it what he is going to have next. Milk is the only article of diet which contains in itself all the essential elements of nutrition. It is, therefore, the only thing upon which you may allow your patient entirely to subsist for any length of time. The most concentrated forms of food are to be preferred, such as convey the greatest amount of nourishment in the smallest bulk.

Whatever you give, be sure that it is the best of its kind—milk perfectly sweet, eggs above suspicion. Remember that you have more than the ordinary fastidiousness to contend with, and never offer a sick person anything which you have not previously tasted yourself, and so feel absolutely sure of. This does *not* mean that you are to taste it in his presence. Bring only so much as can be taken at once. A large amount looks so discouraging that it destroys the appetite for even a little. Take away promptly what is not eaten. It is worse than useless to leave it in sight in the hope that it will soon be wanted. Give only a small quantity of food at a time, but give it at short and *regular* intervals. A cupful every two hours is more easily managed by weak digestive organs than would be a large meal three times a day. When a table-spoonful can not be taken hourly without distress, you may give successfully a tea-spoonful every quarter of an hour. The idiosyncrasies of each individual case must be considered. Regularity is, however, always important. When you do not feed your patient again until morning, it is well to give him some light and easily assimilated nourishment the last thing at night.

If you have a helpless patient to feed, do it slowly, and avoid unmanageable quantities. It requires attention and care to do this well without making an external application of it. Fluid food is most easily given, and with the least exertion on the part of the patient, through a bent glass tube.

Serve the food in as attractive a form as possible. If it pleases the eye, it has a much better chance of proving acceptable to a delicate appetite. You can at least have the dishes spotlessly clean, and dry on the outside. Have hot things hot, and cold ones very cold. To successfully cater to the capricious appetite of an invalid requires the faculty of observation, judgment, and no little ingenuity; but it is worth the exercise of them all, for in most cases the question of nourishment is more important than that of medicine.

Give medicine or stimulant ordered always on time, and measure it accurately. Acquire the habit of always reading the label before you open a bottle. Pour the contents from the unlabeled side. Cork tightly after using, as many drugs lose their virtue upon exposure to the air. Use no remedies, however beneficial you may fancy they would be, without the approval of the physician in attendance. You may otherwise most disastrously conflict with his plan of treatment.

The patient himself should have no responsibility about the taking of medicine, the preparation of food, or anything else which can be spared him. In all small matters, relieve him entirely of the onus of decision. If there is any doubt in your own mind as to the expediency of this or that measure, do not let him share it. Let him feel that you know, and can be relied upon to do, what is best for him, without any necessity for thought on his part.

Perfect freedom from anxiety and cheerful surroundings are as essential for his mental, as are free ventilation, absolute cleanliness, and nourishing food for his physical, well-being. These are the elements of good nursing, and surely they are within the reach of all. Secure these, and you will have given the sick person under your care the best possible chance for recovery; at least you will ameliorate his sufferings, and relieve him from many an unnecessary aggravation.

THE DECREASE OF GOLD.

By F. von BRIESEN.

WHEN, in the beginning of 1850, California and Australia sent annually about one hundred and eighty million dollars of gold into the world, national economists became frightened, and Michel Chevalier and Cobden expressed the fear that the world would be completely inundated with a flood of gold. But when, after the year 1867, this production decreased with alarming rapidity, the opposite fears were expressed. As early as 1869, the London "Economist," when reviewing the year past, said that it would be a great blessing if new sources of gold could be discovered, since the production of thirty thousand pounds sterling per year was barely sufficient to cover the necessities of a flourishing commerce, more especially since America consumed a great part of the gold for itself, thus withdrawing it from the European market. Notable statesmen saw in it the cause of the periodically recurring commercial crises; and Professor Süss, of Vienna, demonstrated in his pamphlet, "The Future of Gold," that the present sources of gold are being exhausted, and that the territory in which new deposits might be found is gradually diminishing in extent.

It is not our purpose, however, to dissuss the national, economical side of the question, but merely to consider it in its scientific bearing.

Gold and silver are the so-called precious metals, for the simple reason that they are rare. But, if we ask why gold is so scarce, Dr. Süss answers that its scarcity is caused by its specific gravity.

We possess three metals distinguished for their great density—iridium, platinum, and gold. If we assume the weight of water as unity, the gravity of these metals is—iridium, 22·23; platinum, 21·50; gold, 19·25. With the exception of iridium, rare as well as remarkable, gold and platinum weigh more than any other metal: for instance, lead has a specific gravity of 11·35; silver, 10·47; copper, 8·80; and iron, only 7·84. The question occurs next, whether the scarcity of gold stands in any connection with its gravity.

Since the earth originally passed from a gaseous into a fluid state, the heaviest components must, in its fluid condition, have tended toward the center. If it be true that our entire planetary system developed from an immense nebula, it follows that the planets nearest to the center must be the heaviest.

"Their great specific gravity," says Professor Petzholt, speaking of metals, "is the reason that they can so rarely be seen on the surface of the earth; the largest masses are to be found within the interior, in a molten condition, and are there protected against the cupidity of man."

Further observations have confirmed the truth of this view. Because spectral analysis reveals no gold in the sun, we must accept the fact that it lies hidden in its interior, and that it is covered by lighter bodies, which, in a gaseous state, form the photosphere of the sun. Hydrogen, the lightest of all gases, constitutes the chief component of this photosphere. Now, the planets are divided into two groups, according to their weight: the heavy, which lie within, and the light, which lie beyond, the circle of the asteroids. Mercury, the nearest to the sun, is seven times as heavy as water; Venus, the Earth, and Mars are five times as heavy; while Jupiter barely attains the weight of water. The specific weight of Saturn is 0·73; of Uranus, 0·84; consequently, they are lighter than water. The density of Neptune, not yet exactly determined, is at any rate very small. We therefore find in our planetary system that the densest bodies are nearest to the center, and this leads us to the presumption that the same law governs on each individual planet, and that, therefore, the heavy gold must be found nearest to the center.

This leads to the question, Whence the gold and platinum to be found upon the surface of the earth? These two heavy metals are only found in places where volcanic rocks have penetrated through earlier formations, and the granite has split up. Platinum, only found in excess in the Ural Mountains, is obtained from rocks that have come up from below; gold is found only in quartz-veins. These veins have been formed in the following manner: As a natural consequence of the contraction of the earth's crust, internal revolutions, and volcanic eruptions, crevices opened, which were partly filled by hot springs, partly by eruptions with quartz. Rich deposits are often found in these crevices, called by the American miners "pockets," or "bonanzas"; but, besides these bonanzas, crevices contain no gold, and only the hope of encountering them leads to their being worked.

The places in which gold is found may be divided into the following three classes—auriferous ore, auriferous veins, and auriferous alluvium:

The first group contains ore, rich in magnesium, interspersed with gold. It is frequently found in the Ural Mountains. As a transition to the second class may be regarded the auriferous minerals, in rock of volcanic origin, as it occurs on the west coast of South America and in many parts of Brazil. The granite of the Erz Gebirge, in Bohemia, which contains tin, is a similar formation. Interesting as this class is, considered from a geological stand-point, it is of little practical value to the gold miner.

The next class consists of the auriferous veins, which are fissures filled by hot springs, geysers, or volcanic eruptions. The gold is found here together with silver, as in the case of the Comstock lode, in Nevada, the gold deposits in Queensland and New Zealand, as well as the mines near Kremnitz, in the Carpathian range, in Hungary. The gold is sometimes found in them pure, sometimes mixed with silver, copper, or sulphur. In the older volcanic veins the gold is not mixed with silver, and bonanzas are never found in them. In many of these veins, also, granite veins are encountered, and, although remote from volcanic regions, it is presumed that the gold was carried up by the granite. The celebrated "Mother lode" of California is a sample of this kind.

The third class is the gold-bearing alluvium. This alluvium (earth washed down by rivers upon lower lands) has been produced by the decomposition of auriferous rock, and the gold is found in grains and lumps to the size of a hen's egg. It is a peculiar fact that the gold found in these deposits is purer than that contained in the veins from which it originated, nor is the formation of lumps and grains satisfactorily explained. The deposits of California, Australia, and Siberia pertain to this group, which may again be subdivided into—*a*. Deposits on the earth's surface, from which the gold is obtained by simple washing; *b*. Deposits which have been covered by subsequent inundations, and from which the gold has to be mined only by difficult work and great expense. These old deposits in California are frequently covered with basalt or lava, and are called "deep leads." They are worked by the hydraulic system: the water is conducted through pipes, and directed with full force against the soil, which is hereby converted into a fluid mud, and passes in this condition through a long line of sluices, set in zigzag, in which the particles of gold are deposited.

The most remarkable deposits of this kind are to be found at Ballarat, Australia, where they are covered with four hundred feet of ground and four layers of lava, which have come from a neighboring volcano. These deposits are the banks and bars of former streams, which have subsequently been filled up. The greatest part of the gold comes from these sources. Dr. Süss estimates that, of all the gold which has been mined between the years 1848 and 1875, the working of the ore has yielded 12·02, while that of the former deposits furnished 87·98 per cent.

Since these deposits are exhausted, attention has for the past few years been directed to the working of the ore. As soon as gold-mines are exhausted, new ones must be found. While the mining of silver is sometimes continued in the same regions for centuries, that of gold is always of short duration, wherefore gold-mines are only to be found in the extreme limits of civilization. Herodotus remarked, when speaking of the quantity of gold-dust paid as a tribute to Darius by the inhabitants of India, that the greatest treasures always come from the most remote places of the earth. The old countries have entirely ceased to be productive, and search must be instituted in the yet unexplored regions in order to discover new fields.

Gold was in excess in ancient times, and mostly taken from the rivers in Asia. The fables of Pactolus, of the golden fleece of the Argonauts, of the gold from Ophir, the history of King Midas, etc., all point to an Eastern origin of this metal. According to Pliny, Cyrus returned with 34,000 Roman pounds of gold (about $10,000,000). The treasures exacted from Persia by Alexander the Great amounted to 351,000 talents, or $400,000,000. Gold also came from Arabia, and upon the Nile from the interior of Africa. Pliny calls Asturias the country in which the most gold is found. A tablet bearing the following inscription was found in Idanha Velha, Portugal: "Claudius Rufus returns his thanks to Jupiter for having permitted him to find one hundred and thirty pounds of gold."

These sources of wealth have ceased to flow, and the endeavor of several Englishmen to reopen them have been unsuccessful. Bohemia, Mähren, Silesia, and Tyrol, all have produced gold, and the receding of the glaciers has caused old mines to be uncovered, while upon the Italian side, at Monte Rosa, Val Sesina, and Val Ansaca, gold-mines are still worked to-day, although with indifferent success. The only works of any note are those of Kremnitz, Hungary. It may, therefore, be safely asserted that Europe is completely exhausted in this respect.

After America was discovered, the Antilles, especially Hispaniola, and the western coast of Mexico, furnished incredible quantities of gold. That used by Alexander VI to gild Saint Mary Maggiore came from Hispaniola, as is seen by the following inscription: "Quod primo Catholici reges ex India receperant." But the production of these mines did not last long.

We find several peculiar statements, with regard to the mining of gold, in an old Dutch book, printed in Amsterdam in the year 1590. It says: "Gold comes from different countries, from the mountains in

Bohemia, and the rivers in Sweden. More than twenty thousand pounds came formerly from Spain, but these mines are exhausted. It came next from the Spanish Indies, first from San Domingo, then from other parts, but that also has stopped. It comes at present from Peru, formerly three millions annually, at present five, six, and eight millions, but it will not be long until these mines also will be exhausted and abandoned." The prophecy of the old book has been fulfilled.

Humboldt entertained great hopes of New Granada and Colombia, where precious metals are found, but, in spite of English capital and highly-improved machinery, the mines do not produce beyond two millions annually.

The Indians of Chili, Peru, and the entire western coast of South America, formerly dug much gold from the alluvium ; they obtained plenty of silver afterward, but little gold, while at the present time they produce ten or twelve times less than at the time of Humboldt's visit. The total production of South America, except Brazil, from 1500 to 1875, was about thirteen hundred million dollars. We can nowhere follow the history of mining better than in Brazil. Toward the end of the sixteenth century the inhabitants of São Paulo were struck with the gold trinkets worn by the savages, and they began washing. In the year 1697 Bartholomeo Bueno found rich gold deposits in the province of Minas Geraes, in consequence of which many adventurers went there, and a war broke out between the Paulists and the Portuguese. The governor finally succeeded in restoring peace, and gold-washing was prosecuted according to a fixed system, whereby the mines became very productive. Towns were built—for instance, Villa Rica—and people flocked from all regions. The province of Matto Grosso, after the year 1720, ceased to produce gold, and in the eighteenth century Brazil occupied the place of California in the nineteenth. Minas Geraes alone, in the middle of the eighteenth century, produced seven, and Brazil ten, million dollars per year, but the deposits were soon exhausted, and toward 1820 the entire production of Brazil had dwindled to five hundred thousand dollars. The leads were next commenced to be worked, but without success, in spite of the vast sums expended upon them by large capitalists. Brazil, which a hundred years ago excelled any other country in the production of gold, has in this respect become fully impoverished within the last fifty years. Its total production, from the end of the sixteenth century up to to-day, amounts to one hundred and sixty million dollars.

In ancient times, and in the beginning of the middle ages, Africa was known as the gold country. Herodotus speaks of the Carthaginians, who gathered gold on the other side of the Pillars of Hercules ; the Arabian geographer El Edrisi (1154) speaks of gold in Wangara, the source of the Niger, and the same mention is made by the Moor, Leo Africanus, who was baptized by Pope Leo X ; he had explored

Africa and the countries of Wangara and Timbuctoo. The Moors of Spain and Northern Africa obtained their precious metals from these countries. The French of Senegal lately took possession of them. They still found gold, but no longer in paying quantities, and the once famous Gold Coast at present furnishes not half a million dollars per year. The auriferous sand is washed by the negroes during leisure hours, and they are content with a yield which would ruin a European enterprise.

The Egyptians obtained their gold from the upper Nile and Ethiopia, attested by inscriptions dating from the year 1600 before Christ. Herodotus mentions a king of Ethiopia who was attacked by Cambyses, but not conquered, who shackled his prisoners with golden chains, since gold was more common than bronze. According to Edrisi, there was so much gold in Sofala that a copper trinket was worth more than one of gold. The celebrated explorer Mauch, in 1867, found the remains of ancient gold-mines, but the gold of Africa belongs to the past. The celebrated necklace of the Queen Aalic Topeh, said to be three thousand six hundred years old, and still to be seen in Boolak; the gold chains worn by the Afghan prisoners at the time of Cambyses; the treasures brought by the Queen of Sheba to Solomon's Temple; the masses of gold with which the throne of the King of Ghana was adorned—all these, no matter whether they be fables or not, indubitably point to the former immense gold wealth of Africa, while to-day it produces barely a million dollars. Entire Northern Africa, as far as the Sahara and the Falls of the Nile, consists of sedimentary ground, which never can have furnished metals; but in the interior we find old rock—granite, gneiss, and hornblende—and there the auriferous alluvial soil had been formed; but it appears that it has been thoroughly exhausted in antiquity and the middle ages. According to Ab. Jevones, the natives have been the first to discover auriferous sand. It is, therefore, possible that the interior country still contains deposits, and even bonanzas, but large ones may no longer be expected, since its gold would long ago have reached the coast.

Neither China nor Japan produces sufficient gold for home consumption.

The three chief sources are at present Siberia, the United States, and Australia, while the last two are becoming exhausted. An immense alluvial territory exists in Siberia, covering the entire space from the Ural to the river Amoor, but the climate prevents washing during the greater part of the year. Here, similar to California, gold is found wherever granite fills the fissures. Although the yield of the washings is gradually decreasing, it is really increased by daily discoveries of new fields, and amounts at present to about $28,000,000 annually. The greatest quantity of gold has of late years been mined in America, partly due to its natural wealth, partly to the energy brought to bear for obtaining it. Volcanic forces have brought gold as well as silver to the surface in the Rocky Mountains, but its exhaustion is approaching rapidly. Montana, in 1866, produced $18,000,000, while to-day its yield is $2,500,000 ; Idaho, from 1864 to 1871, yielded from $5,000,000 to $7,000,000, which in the year 1880 has decreased to $1,510,546 ; Oregon and Washington yielded, in the year 1868, $4,000,000 ; in 1879, not more than $1,275,000 ; Dakota has increased a little, and produced $2,420,000 in 1879 ; Colorado has an average yield of $3,000,000 ; California has passed through the several stages of a gold-producing country ; the washing of the river-sands, after 1848, produced immense wealth, while at present only the Chinese are engaged in it, and earn a bare living. The gold on the surface is exhausted, and only the deep deposits and the veins remain to be worked.

It has been estimated that $1,200,000,000 of gold and silver have been mined in the West of the United States within the last thirty years ; and that, in spite of the recklessness and extravagance which characterized the two decades from 1849 to 1869, a net profit of $30,000,000 per year was realized. Since 1850, the money invested and the labor expended in mining in the West for precious metals are estimated at $710,000,000. What may fairly be called the mining territory of the United States embraces an area of 1,190,000 square miles, with a population of barely 1,500,000.

The entire ridge of the Sierra Nevada consists of granite ; but on the western slope limestone is found mixed with it. Where these two rocks come together, a belt from eight to nine miles wide, and running from north to south, is found, which contains all the gold leads of the district. The "Mother lode" commences at Mariposa, passes through the northern boundary of the State, and is covered by the lava of the large (not yet extinguished) volcanoes Pilot Peak and Lossan Peak farther north. This lava also covers an old alluvial bottom with overlying layers of basalt from fifty to two hundred feet thick, and these form the so-called "Table Mountains." We find the same formation south of the Sierra Nevada, near the "Big Trees," where the sedimentary deposits, lying upon granite, are covered with basalt. From here the auriferous sand was washed away by mountain-streams, and appeared on the surface. These deep deposits, in connection with the offshoots of the Mother lode, still sustain the gold production of California at from fifteen to seventeen million dollars.

In Nevada was discovered the Comstock lode, for a long time held to be inexhaustible, and this is also covered with later volcanic formation. The largest of these bonanzas is the Gold Hill mine, which lies 700 feet deep, and several companies have commenced to work this rich vein. The most important, the Virginia Consolidated, has sunk a shaft 1,600 feet deep, and driven a tunnel of 20,000 feet in length through the side of the mountain, projected by Engineer Sutro, Africa and the countries of Wangara and Timbuctoo. The Moo[illegible] Spain and Northern Africa obtained their precious metals from [illegible] countries. The French of Senegal lately took possession of th[illegible] They still found gold but no longer in paying quantities, and the [illegible] famous Gold Coast at present furnishes not half a million dollars [illegible] year. The auriferous sand is washed by the negroes during lei[illegible] hours, and they are content with a yield which would ruin a Europ[illegible] enterprise.

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[illegible] on a [illegible] an, [illegible] entire "Creed of Christendom." But, perhaps, Matthew Arnold's "Empedocles on Etna," which appeared in 1853, best enables us to appreciate the religious state of the younger generation. The soul of man hangs like a mirror, blown upon by every wind, and—

"A thousand glimpses wins,
And never sees a whole."

Man is the sport of the gods, man—

"Who knows not what to believe,
Since he sees nothing clear,
And dare stamp nothing false where he finds nothing sure."

The gospel of the writer is that of Stoicism:

"Once read thy own breast right,
And thou hast done with fears;
Man gets no other light,
Search he a thousand years."

He repudiates all compromises such as that which had been offered by "In Memoriam":

"Born into life!—who lists,
May what is false hold dear,
And for himself make mists
Through which to see less clear;
The world is what it is, for all our dust and din.

. . . .

"Streams will not curb their pride,
The just man not to entomb,
Nor lightnings go aside
To give his virtues room;
Nor is that wind less rough which blows a good man's barge.

. . . .

"Fools! That in man's brief term
He can not all things view,
Affords no ground to affirm
That there are gods who do;
Nor does being weary prove that he has where to rest."

The impression one gets from such a poem is one of despair; the agnostic tone is quite as pronounced as that of any writer at the present day; but there is much less hope, no outlook into the future, no talk of the future destiny of humanity, which, however vague and dreamy, is better than the dead level of an agnostic introspection. And yet this poem was written by one whose contemporary writings are quite free from this despairing tone, who has faith in a tendency not ourselves, and believes that we can learn something of it from the Bible and the best literature of all ages. This change in tone, which is not peculiar to Matthew Arnold, I attribute to a great extent to the new vistas opened up by the school of evolutionists, and by the writers who have drawn attention off mere umbilicular contemplation such as Morris, Rossetti, and Swinburne. We have accordingly to trace in the succeeding years the rise of new schools of thought, as well as the several attempts of religious writers to accommodate traditional religion to the new light thrown upon it. This will take us through twenty years, up to the memorable years 1873–'74, when the different schools came into open antagonism.

To trace out the different lines of thought with any fullness would require a separate study; as I am simply passing over the ground with the view of setting a single book in a clearer light, I must content myself with mentioning the names of a few leading works, with their dates. The rise of the evolution school was heralded in 1845 by Robert Chambers's "Vestiges of the Natural History of Creation," an expansion of the Lamarckian theories of natural development. But the writings by which what we now mean by evolution were popularized fall within the present period. "The Origin of Species" appeared in 1859, Spencer's "First Principles" in 1862, Huxley's "Evidence as to Man's Place in Nature" in 1863, and "The Descent of Man" in 1871. With this school also we may class Max Müller's "Lectures on the Science of Language," which appeared in 1861, as tending to widen the conception of evolution. Of the effects of this new view of life upon religious thought it is not too much to say that, if it cut the ground from under the intuitionalist theory of right and wrong, and of the origin of conscience, to the skeptic in regard to supernaturalism it gave a prospect and a future glorious with hope. To many minds the ascent of man serves a more glorious conception than his fall. The door was opened for a pantheistic view of the universe, and this tendency was enhanced by the influence of Ruskin, who was already writing in 1850. George Eliot, who has exercised a distinct influence upon the age by popularizing the ethical side of positivism, and showing men that it gives a work-a-day theory of life, began to publish in the year 1858.

What has been called the fleshly, and more recently the æsthetic school of poetry, is best represented by the names of Swinburne, William Morris, and Dante Gabriel Rossetti. Swinburne's works are too numerous to mention, but his "Chastelard" appeared in 1865, his "Poems and Ballads," of unhappy notoriety, in the following year; Morris's "Defense of Guinevere," his first work, appeared in 1858, his "Earthly Paradise" in 1868; Rossetti's first celebrated volume of "Poems" appeared in 1870. Of this school it may be said that, without being brought into actual contact with supernaturalism, the tendency of their writings was to take men's thoughts into a different field, to consecrate the passions and sentiment, to revive with a difference the old Greek modes of looking at man and his destiny in the world. With this school we must rank the important name of Walt Whitman, whose first series of "Leaves of Grass" came in 1855. Of course his influ ence was more catholic than that of the fleshly school, properly so called, his aim being the apotheosis of man as man. Three lines from "One's Self I Sing" reveal to us clearly his point of view:

> "Of physiology from top to toe I sing;
> Not physiognomy alone, nor brain alone, is worthy for the Muse—I say the form complete is worthier far;
> The female equally with the male I sing."

Of what may be called skeptical writers, i. e., writers who treated different branches of study in a manner hostile to Christianity, and with their eyes distinctly turned upon it, it will be sufficient to mention Buckle, whose "History of Civilization" appeared in 1857; Draper, whose "Intellectual Development of Europe" was published in 1861; and Lecky, whose "Rationalism" appeared in 1865, and his work on "European Morals" in 1869. Dr. Jowett's "Plato" appeared in 1871, the introductions to the separate dialogues of which were a distinct contribution to contemporary thought, while they are valuable as a fair index to the results of moderate liberalism of the time in different fields. Thus, in his introduction to the "Republic," he defines the modern notion of God as an "intelligent principle of law and order in the universe, embracing equally man and nature." Spencer's "Study of Sociology" appeared in 1872, and the "Fortnightly Review" was started in 1865. In tracing the line of thought taken by writers more immediately concerned with the book before us, we come first to "Essays and Reviews" in 1860. Archdeacon Pratt had published, in 1856, an attempt to prove that Scripture and science were not at variance. The publication of the volume of "Essays and Reviews" may be taken as a symptom that intellectual Churchmen felt that the old stand was no longer possible; that concessions must be made to modern science, modern investigations, and modern thought; that the proper way to judge of an ancient work was to interpret it by the light of its own day. These views were to some extent popularized by the first series of Stanley's "Lectures on the History of the Jewish Church," appearing in 1863, the year following the publication of Bishop Colenso's work on the Pentateuch and the Book of Joshua. Stanley's preface tells us that it is his intention "to present the main characters and events of sacred narrative in a form *as nearly historical as the facts of the case will admit*"; to set the characters and institutions of the time in a clearer light; "to *recognize in sacred subjects their identity with our own flesh and blood*," at the same time not "wishing to efface the distinction which *good taste*, no less than reverence, will always endeavor to preserve between the Jewish and other histories." "Ecce Homo" appeared in 1865. It was an attempt to base religion upon the enthusiasm of humanity as preached by the man Christ, and was succinctly characterized at the time by a pious nobleman as "vomited from the jaws of hell." The author, now universally recognized as Professor Seeley, promised a supplementary volume of applications of his theory. This has never appeared, and we may look upon the present work as the fulfillment of his promise. The wide difference between them must be ascribed to the progress since made by liberal thought. Still, "Ecce Homo" was regarded with fear and disgust in its day by the orthodox among all sections of Christianity, and at once provoked an eloquent and, from Professor Seeley's point of view, unanswerable rejoinder in Dr. Liddon's Bampton Lectures "On the Divinity of Christ," delivered at Oxford in the following year.

We now come to the two celebrated years 1873 and 1874—years of open utterance on all sides, and which we may look upon as the crisis of the revolution of thought. In these years appeared the first two volumes of "Supernatural Religion," an elaborate investigation from two points of view into the foundations of Christianity, and Matthew Arnold's "Literature and Dogma," an attempt to rehabilitate Christianity, while openly recognizing the futility of all attempts to base it upon miracles or the supernatural. Christianity was to remain in force, but without a personal God. At such a moment, Leslie Stephen's direct question, "Are we Christians?" came home to us with full force. It was anticipated, by one year, by the amusing *brochure* entitled "Modern Christianity, a Civilized Heathenism." In the same year Max Müller carried the critical spirit of science into religion itself in his "Introduction to the Science of Religion." Meanwhile, there appeared a beautiful volume, carefully printed upon exquisite paper, containing "Studies in the History of the Renaissance," which their author, Mr. Pater, concluded with the following words: "We are all *condamnés*, as Victor Hugo says, '*Les hommes sont tous condamnés à morte avec des sursis indéfinces*'; we have an interval, and then our place knows us no more. Some spend this interval in listlessness, some in high passions, the wisest in art and song. For our one chance is in expanding that interval, in getting as many pulsations as possible into the given time. High passions give one this quickened sense of life, ecstasy and sorrow of love, political or religious enthusiasms, or the 'enthusiasm of humanity.' Only, be sure it is passion, that it does yield you this fruit of a quickened, multiplied consciousness. Of this wisdom, the poetic passion, the desire of beauty, the love of art for art's sake, has most; for art comes to you professing frankly to give nothing but the highest quality to your moments as they pass, and simply for those moments' sake."

In 1874 appeared Green's "Short History of the English People," of the importance of which I shall speak presently; Mill's "Autobiography," revealing the blameless life of a true humanitarian who had lived without a God, in the ordinary acceptation of the term; and George Eliot's "Jubal, and other Poems." In this volume the religious aspirations of the new faith were thus given poetical expression:

"O may I join the choir invisible,
Of those immortal dead who live again
In minds made better by their presence: live
In pulses stirred to generosity,
In deeds of daring rectitude, in scorn
For miserable aims that end with self;
In thoughts sublime that pierce the night like stars,
And, with their mild persistence, urge men's search
To vaster issues. *So to live is heaven.*"

In this year, too, at Belfast, Professor Tyndall delivered, before the British Association, his celebrated address, in which, "abandoning all disguise," he says that "the confession that I feel bound to make before you is, that I prolong the vision backward across the boundary of the experimental evidence, and discern, in that matter which we, in our ignorance and notwithstanding our professed reverence for its Creator, have hitherto covered with opprobrium, the promise and potency of every form and quality of life."* The discovery, if it may be called so, was not exactly a new one. The same avowal had been made, more than twenty years before, by W. B. Carpenter, but the rise of the evolution school in the interim caused an importance to attach to Professor Tyndall's utterances that has not attended upon Dr. Carpenter's.† The address at once took rank as the high-water mark of materialism. Lastly, in the same year, we come to Greg's "Warnings of Cassandra," and to a work which, together with this, is symptomatic of the feelings of the next few years—Hartmann's "Philosophy of the Unknowable."‡

The prevailing tone, after the battle had been fought, was one of despair and pessimism. Science had won the victory, but thoughtful minds, even on that side, saw that it might be possible to push it too far. Hence came attempts at compromise, the cry for which went up, in 1874, from John Morley, the editor of the "Fortnightly Review," the chief Positivist organ. Still, for the present, the general tone was disheartening in the extreme, and its influence is traceable in many ways. Poetry has been distinctly deteriorated by it. In politics it led to a temporary reaction in favor of conservatism. Life appeared to be, as Pope had said, a mighty maze, but the plan was lost. Instead of the authoritative tone of the Church, the voices of different

* Quoted from the original, as reprinted in "Nature." The passage is reworded in the published address. The variations between the two are curious, and well worthy of study.

† For Dr. Carpenter's words, see his article upon "Life," in Todd's "Cyclopædia of Anatomy and Physiology," vol. iii, p. 150. This work appeared in 1847. He refers, in a foot-note, to an earlier essay, on the laws regulating vital and physical phenomena, in the "Edinburgh Philosophical Journal," April, 1838.

‡ I may here remark that I have confined my review to works in the English language. Many foreign names, such as Strauss and Haeckel, will occur to every one. To have extended my review to these would have required a separate essay.

schools were heard bidding against one another for adherents. This condition of affairs was cleverly brought home to readers by "The New Republic," Mr. Mallock's first work, appearing in 1878. To minds distracted by the hubbub of opinion, and despairing of certainty elsewhere, the only sure refuge again appeared to lie in the Church of Rome, and this, as the only alternative for the gospel of Positivism, was offered in the book entitled "Is Life worth Living?" which was published in 1879. "The Romance of the Nineteenth Century" appeared two years afterward. Such a temporary depression of tone was a natural result of the conflict through which the age had been passing.

But other and more important results followed. It is unequivocally recognized, by most writers of eminence, that Christianity can no longer look to its supernatural elements for support—nay, more, that the excellence of some parts of its morality can not even receive credence for their inferential elements; at least they have to be definitely discarded as a necessary part of faith, if Christianity intends to bid for the allegiance of the intellectual portion of mankind. It is therefore ridiculously wide of the truth to boast, as the clerical mind is inclined to do, that Christianity has weathered the storm, that she will pass into the twentieth century unaltered in essentials. This is fully recognized by the author of "Natural Religion." "The Church," he writes, "has now entered upon that phase when minds of the higher order are seldom found to receive its ancient dogmas with complete conviction, when they do not altogether belong to it, even when they most admire it, and most appreciate the service it has rendered to mankind. It has reached this rather advanced stage of decline, and has left quite behind it the first stage when individual disbelievers were indeed numerous enough, but still minds disposed to religion, even when they were minds of the highest order, were troubled with no skepticism that they could not overcome." The fact is, that the Church does not pretend to be the interpreter of human society, to open to us the vista of the future, or to give us guidance upon matters of contemporary importance. "We know," writes our author, "that for the most part it is occupied with quite other topics. To most of its utterances the world listens in half-contemptuous silence, feeling that it is useless to controvert the propositions laid down, and that no results would follow from admitting them. The propositions are *archaic*; they show that the Church *once* understood its function, and discharged it efficiently."

The natural result has been, that its authority has been quietly disregarded by all branches of investigation. Before 1873 and 1874, hostility to orthodox Christianity was more or less openly shown by the chief writers of science, history, art, morals, etc., but since these years this tone has been generally abandoned for one of supreme indifference, or of perfect fairness. The tone of the "Fortnightly Review," which had led the van in the attack on the Church, has visibly changed, and has thrown aside the unfairness and Positivist provincialism, which was its note ten years ago. Thus, again, instead of covertly sneering at the marvels of the Bible and Christianity, as Grote and Buckle loved to do, Mr. Green finds no difficulty, in his "History," in fully acknowledging all that the Church had done for the civilization of England. But this does not close his eyes to the facts of the case, or prevent his recognizing, in the Bible literature, a heterogeneous collection of "legends and annals, war-song and psalm, state-rolls and biographies, etc." It should be remembered that Mr. Green's history was intended for the student; that it was written by a clergyman, and one who had been an earnest worker in the purlieus of eastern London; and, lastly, that this free tone in regard to matters of religion, a tone that recognized with equal impartiality Protestant and Catholic, has never been objected to as unfitting the book for general use. Thus we may say that history has been emancipated. The revision testifies to the emancipation of scholarship.

Another important result of the battle of opinion was the perfect freedom with which different writers now expressed themselves, as well as in the toleration that they mutually extended to one another. As it were to mark this era, a new review was started in March, 1877, as a perfectly free medium for all shades of honest opinion. A poem was contributed by the poet-laureate as a preface, which we quote as distinctive of the "Nineteenth Century":

"Those that of late had fleeted far and fast
To touch all shores, now leaving to the skill
Of others their old craft seaworthy still,
Have chartered this; where, mindful of the past,
Our true co-mates regather round the mast,
Of diverse tongue, but with a common will
Here, in this roaring moon of daffodil
And crocus, to put forth and brave the blast;
For some, descending from the sacred peak
Of hoar, high-templed Faith, have leagued again
Their lot with ours to rove the world about;
And some are wilder comrades, sworn to seek
If any golden harbor be for men
In seas of Death and sunless gulfs of Doubt."

But on two sides something more is observable. Art and science not only claim to be completely free from the power of Church dictation; they have set up, so to speak, an opposition Church. Science was emancipated in 1874, it has since turned its attention to the construction of a scientific morality. The "Data of Ethics" appeared in 1879, but long before this science had shown itself capable of rising to the enthusiasm of a religion, and we have to thank the author of "The New Paul and Virginia" for laboriously collecting the utterances of men of science upon this point in the notes appended to that work. It is true that all men of science do not associate their worship with the name of God, but we are fully in agreement with our author when he writes: "By what names they call the object of their contemplation is in itself a matter of little importance. Whether they say God, or prefer to say Nature, the important thing is that their minds are filled with the sense of a Power to all appearances infinite and eternal, a Power to which their own being is inseparably connected, in the knowledge of whose ways alone are safety and well-being, in the contemplation of which they find a beatific vision."

The claims of art to an independent position, to a right to the undivided attention of its votaries, are no less unequivocal. When W. Morris published his "Earthly Paradise" in 1868, he prefaced it with an "Apology," in which he acknowledged the littleness of his undertaking, almost lamenting that he could not rise to higher work:

> "Of heaven or hell I have no power to sing,
> I can not ease the burden of your fears,
> Or make quick-coming death a little thing,
> Or bring again the pleasure of past years,
> Nor for my words shall ye forget your tears,
> Or hope again for aught that I can say,
> The idle singer of an empty day."

He only professes to tell

> ". . . a tale not too importunate
> To those who in the sleepy region stay."

I have quoted Mr. Pater's claim for art put forth in 1873. Listen, lastly, to the terms in which the newest singer bids his soul abandon the secular world:

> ". . . O come out of it,
> Come out of it, my soul, thou art not fit
> For this vile traffic-house, where day by day
> Wisdom and reverence are sold at mart,
> And the rude people rage with ignorant cries
> Against an heritage of centuries.
> It mars my calm: wherefore in dreams of Art
> And loftiest culture I would stand apart,
> Neither for God, nor for his enemies."

To sum up the intellectual and religious revolution of the last few years: Matthew Arnold's poetry aptly represents the tone of mind of advanced religious thinkers during the fifties. Looked at from the orthodox stand-point, his poems are intended, like the reasonings of the devils in hell upon theological problems, to—

> ". . . arm the obdurèd breast
> With stubborn patience as with triple steel."

Matthew Arnold aptly expresses his own point of view when he speaks of himself as

> "Wandering between two worlds, one dead,
> The other powerless to be born,
> With nowhere yet to rest my head."

or, again:

> ". . . The sea of faith
> Was once, too, at the full, and round earth's shore
> Lay like the folds of a bright girdle furled,
> But now I only hear
> Its melancholy, long, withdrawing roar,
> Retreating to the breath
> Of the night-wind, down the vast edges drear
> And naked shingles of the world."

Meanwhile, as the old faith began to lose power, art, science, and the religion of humanity stepped forward into prominence, at first in antagonism to Christianity. The struggle became critical during the years 1873–'74, and left a feeling of despair and pessimism for a time on men's minds. But with time this feeling has begun to wear off, and we see that the allegiance formerly claimed for the old theology is claimed now by its rivals. The interval of pessimism, the period of dormant anarchy, was marked by many gropings in different directions. Scholars drew attention to the great rivals of Christianity, to Judaism, to Mohammedanism, to Buddhism. To this we owe in part such books as "Daniel Deronda" (1876) and "The Light of Asia" (1879). The theories of great philosophers of the past began to be studied with fresh attention, especially the writings of Plato and Aristotle, of Berkeley, Spinoza, and Kant. Even spiritualism and the doctrine of metempsychosis were found to give the support needed to unscientific souls who lacked the courage to stand by the old orthodoxy which the *Zeit-geist* had condemned.

The need of some reconstruction was felt even by philosophers of the new school. Spencer propounded an evolution theory of morals in his "Data of Ethics" (1879); and George Eliot, as a reconstructive radical, in her "Theophrastus Such" (1879), drew attention to the fact that "ideas acquired long ago reappear as the sequence of an awakened interest or a line of inquiry which is really new to us." As stable elements of the religion of the future, she pointed to the love of ideals, and specially to the constantly renewed ideal self; to the value of external nature, as exercising a soothing influence, of family life, and of national sentiments. We are thus led to the work before us. Its importance is due to its recognition of the facts which this short review of the religious thought of the last thirty years has brought into prominence, and it takes up and makes a part of its system the ideas on culture and civilization, which Matthew Arnold has reiterated at intervals, ever since his publication in 1869 of "Culture and Anarchy." I have called it a system, and herein lies its weakness as well as its strength. "Theophrastus Such" was a distinct contribution to the thought of the time, but, through not aiming at the completeness of a system, it failed to secure the attention which would have revealed its short-comings. Many parts of "Natural Religion" are doubtless of great value, but what a writer does not seem to have great faith in personally is not likely to be warmly welcomed by outsiders.

[*To be continued.*]

SCIENTIFIC PHILANTHROPY.

By M. ALFRED FOUILLEE.

II.

We have examined, subjecting them to their just measure, the inconveniences which philanthropy produces when it takes as its rule the vague sentiment of love instead of the precise and scientific ideas of justice and general interest ; it is proper for us to show the advantages which can, in a certain measure, compensate for these inconveniences. This is a point of view on which the Darwinians have not sufficiently insisted.

The first advantage of philanthropic institutions, when they are well conceived and subordinated to the rules of science, is, that they tend to diminish excessive inequality, whether economical, political, or intellectual, among men. The necessity of restoring some degree of equality in mankind arises from the laws of natural selection themselves. It is a remarkable fact that these laws, after having at first appeared favorable to aristocracies and aristocratic institutions, are now invoked in favor of social equality. According to Dr. Jacoby, political and economical inequality, even by virtue of the laws of natural selection, produce "ignorance and misery below, crime and sterility above. . . . From the mass of mankind emerge individuals, families, and races, who tend to rise above the common level ; they toilsomely scale the rugged heights, attain the summit of power, of wealth, and of intelligence, and, when once they have got there, they are cast down and disappear in the depths of folly and degeneracy." Death is the great leveler ; by destroying everything that rises, it democratizes mankind. "Men thus appear to have been organized," according to Dr. Jacoby, "with a view to equality." Every too abrupt distinction into classes, political, economical, or intellectual, and all selection, which is the logical and natural consequence of such distinctions, are equally disastrous to mankind, to the elect as well as to the rest of men ; "they produce with the latter deficiency, with the former excess of the element which is the principle of the distinction of classes." Whenever any part of mankind has too much of anything, whether it be of material goods or intellectual qualities, the rest of the race immediately finds itself having too little, and both parties suffer equally from the excess and from the lack. But Nature seems to desire to avenge herself for such violations of her laws, and cruelly afflicts the elect and fortunate ones, chastising them "to the fourth and seventh generation."

The laws of Nature are immutable, and woe to the man who violates them! "Every privilege a man accords himself is a step toward degeneracy, mental decline, and the death of his race." By abasing whoever tries to raise himself above the common level of mankind, by chastising the haughty, by exacting satisfaction for excess of pleasure, Nature appoints the privileged ones themselves the scourges of their race. "Too much fortune offends and irritates the gods," the ancients thought, and the medical study of the consequences of all intellectual or moral distinction, and of all selection, leads us to the same conclusion. "*Humana imprudentia impares esse voluit quos Deus æquaverat*" ("Human folly desires to make unequal those whom God has made equal"), said Pope Clement IV, but, if this is the case, can the Darwinians complain that philanthropy is trying to diminish in some degree the inequalities that are born of the social *régime?* Does it not, in this case, act in the same direction with Nature, and according to its design?

We should, besides, be less pessimist than Mr. Jacoby in respect to distinctions and selections of every kind. The theory which Mr. Jacoby has deduced from Darwinism, if pushed to the extreme without making necessary distinctions and restrictions, would go to the extent of destroying even the principles from which it is drawn, and would overthrow the laws postulated by Darwin; in effect, all superiority, requiring an expenditure of force, might, by that fact itself, become in the struggle for existence a germ of degeneracy instead of a germ of improvement. There would be nothing really durable except what did not rise above the common level, and living beings would resemble those corals, the madrepores, which grow to form the basis of continents as long as they do not pass the level of the sea, and are not brought to die above the level of its surface. It is necessary to distinguish here between useful and injurious inequalities, between natural and acquired ones; among the last, also, must be distinguished those which are in accord with Nature, and those which are opposed to her. These distinctions, too much neglected by Mr. Jacoby, are the very ones, in our opinion, which scientific philanthropy ought always to have in view. Its aim should be to re-establish, so far as possible, a degree of equality at those points where social arrangements have created artificial inequalities, injurious and contrary to Nature. To spread and equalize general instruction, the moral sentiments, labor, the first and essential instruments of labor, to raise what is down, to bring up to the common light what is in darkness, to restore to life and health what on account of want was threatened with sickness or death, is to do real reparative justice, and at the same time to re-establish some equality among men in the great competition of life ; it is by this very fact to suppress factitious inequalities in order to give free play to natural superiorities, in essence beneficent and no longer malign. It is, we see, the theory of natural selection itself coming to the support of the philanthropic sentiments against which it had furnished objections.

May not this preservation of the weak, which the partisans of Darwin condemn, while it may sometimes become dangerous to the physical health of the race, also save from death useful or even superior minds who, without the cares given by the family or the aid rendered by strangers, might not have been able to live and develop themselves ? Do we have to lament that a Pascal and a Spinoza were rescued from the death with which their feeble constitutions threatened them from their youth ? How many poor children have there been who, by means of the aid they have received, have afterward become great men of science or great artists ! Here, then, is a second advantage of philanthropy. After correcting injurious inequalities, it favors useful superiorities. Furthermore, the preservation of organisms which want would otherwise have destroyed, induces, by virtue of the competition of life, an increasing elevation of intelligence which becomes continually more necessary : all those who can not count on the vigor of their limbs are obliged in the struggle for existence to appeal to their mental faculties. Other men have had to employ considerable intelligence to save them from death, and they are themselves obliged to employ it in their turn to preserve themselves, to support themselves, to secure for themselves a place in the light of the sun. Hence arises a progressive elevation of the intellectual level in the whole mass of the nation. This movement is, in many points, nothing but that of civilization itself, to which philanthropy is correlative.

We meet here a new objection : it is represented that talent, and still more genius, are advantages of individuals which are paid for at the expense of the race. We hear it repeated, with Plato, that a soul which is mistress of itself will knock in vain at the doors of poetry ; with Aristotle, that there is no great genius without a mixture of folly ; and with Seneca, that nothing great or superior to what is vulgar can be manifested without some trouble of mind ; more than this, the objectors would extend to the race of the great man the trouble and the morbid germ which, working itself out in some form or another, will make the children pay dearly for the fame of their fathers. "Every man of genius or talent," says M. Renan, "is a capital accumulated from several generations." "This capital, accumulated and personified in a man," says M. Jacoby, "does not return again to the commonwealth, but is lost from it, at least in a physical point of view; it is withdrawn from circulation, and the only trace it leaves is folly, wretchedness, and degeneracy in posterity." Nothing is made out of nothing, and all production supposes some consumption. Science, art, and ideas, to be born and develop themselves, consume generations and peoples. Individuals and nations exhaust themselves by production, like lands not manured, because the products are not returned to the common ground, and are materially lost to it. M. de Candolle also shows that civilized man, by the very fact of his mental superiority, is generally inferior to the savage in physical force and health. With the savage, in fact, the chief conditions of selection are a piercing sight, a fine hearing, muscular strength, and the faculty of resisting cold, heat, moisture, and hunger. The civilized man has not these qualities in the same degree; what he gains on one side he loses on the other, and the law of equivalence of forces is verified here as elsewhere. The brain grows only at the expense of the muscles; the man who thinks is in a sense a depraved animal. Such are the inconveniences of the intellectual development which modern philanthropy tends to favor at the expense of physical force. We are far from desiring to deny these inconveniences, but conclusions which go further than the premises need not be drawn from them. Social science is doubtless right in saying it is dangerous for individuals and peoples to break entirely the natural equilibrium of physical and mental functions: *mens sana in corpore sano* (a sound mind in a sound body); if a nation becomes physically enfeebled too rapidly, it will have neither time nor means to fortify itself mentally, for intelligence can not make real progress in decaying organisms; all will end in a simultaneous dwindling of mind and body. But it is necessary, on the other side, to look out that the natural movement of civilization be not trammeled. Now, this movement is characterized by the increasing predominance of thought and feeling among modern nations. This predominance favors the development of philanthropy, and is in its turn favored by that through an inevitable reaction. The question of philanthropy, then, when generalized, ultimately becomes confounded with that of civilization itself. Now, it would not do to repeat to-day Rousseau's dissertation against inequality and the arts; we could not take man back to the savage state under the pretext that civilization exhausts his physical forces and the best of his vigor in the intellectual blossoming. The whole of society, in profiting by the discoveries of science or art, profits by the sacrifice of individuals or of their immediate posterity, if there is a sacrifice, and the profit exceeds the loss.

This loss even might be avoided by a better understanding of hygiene and a better system of education; and precisely these ought to be the principal aims of philanthropy. Hitherto the economy of nature, in order to repair the loss incurred by intellectual culture, has been obliged to proceed by a kind of fallowings, by suffering a vegetation too luxuriant and too concentrated at one point to be succeeded by a provisory rest and sterility; but a superior system, which has prevailed in the cultivation of the land, will without doubt be applied some day to the cultivation of the mind: it is the system of allotments and improvements, and it should be made the basis of general education. We can, furthermore, avoid at this point, also, the excessive evils of repartition, the antinomies of intellectual luxury and intellectual want, by the diffusion of knowledge through the mass of the nation; and this is one of the essential objects and one of the beneficent results of scientific philanthropy. Without that, mankind, divided into a class of intelligent men and a class of ignorant ones, would resemble the twins of Presburg, who were united by the after part of the thorax. One of them was bright and gentle, while the other was stupid and ill-natured, and constantly struggling against her sister, notwithstanding both their bodies were united into one; and her violent conduct did harm to both.

In addition to the material and intellectual advantages we have just demonstrated, philanthropy brings precious moral advantage to the whole race. It develops, in the individuals and the people who exercise it, the qualities of heart most important for social life. Darwin and his partisans early recognized how essential to society is the development of altruistic inclinations; even justice is impossible without those inclinations, for they alone can restrain egoism. A society without pity is always careless of the right. Natural selection, which is exercised now to the advantage of the most intelligent peoples, will also in the future, we hope, be exercised to the advantage of the best and most just, when the understanding of the truth shall be complete enough to win over the will of the best. Selection always gives the day to those who adapt themselves most perfectly to the new mediam; and the human medium of the future will without doubt be the reign of fraternity and justice. Those nations only will survive then which shall be best adapted to the altruistic type; that is, which shall be able to live best and to propagate themselves in a medium chiefly intellectual and moral, in which knowledge and sympathy shall have the first rank.

This adaptation of actual societies to the ideal society by the simultaneous advance of science and sympathy, will probably bring about a transformation of the type of the species, a greater development of the brain than of the other organs, a substitution of mental and moral strength for physical force. The actual brain is already an immensely enlarged vertebra; the brain of future races will perhaps be not only in volume but in organization, also and especially, as different from the brain of existing races as that is from simple vertebræ. The nervous system of civilized man is already thirty per cent greater than that of the savage. Now, cerebral development seems to have a restrictive influence on fecundity; it should tend, then, to re-establish that equilibrium between the increase of population and the increase of subsistence which scientific philanthropy seeks to realize, and which it reproaches sentimental charity with destroying. The point is worthy of examination.

What are the laws of the multiplication of species, neglect of which, according to Malthus, Darwin, and Mr. Spencer, is as prejudicial to the philanthropist as to the naturalist, in the connected problems of population, selection, civilization, and benevolence? The first of these laws, as formulated by Messrs. Howorth, Doubleday, and Spencer, is that a greater development of individuality brings on a diminished fecundity for the species: if animals of one species, the human species, for instance, have a more intense individual life than those of another species, the progress in the volume of the brain, in physical or moral development, and in the complexity and activity of the functions, is compensated for as to that species by a lessened generative aptitude. Man is the living species in which individuality and its functions are carried to the highest point; and it is also the least prolific of the species. The reason of this law, according to Mr. Spencer and M. de Candolle, is that the intensity of the individual life implies a taking possession of materials which can no longer serve for other organisms; generation, on the contrary, is a disintegration which subtracts from the organism a part of its substance. In short, individuality is an acquisition; generation is a loss. Now, that which completes individuality, which is what we might call its highest expansion, is the life of the intellect and affections. Consequently, the animal species, or the human races that live most by thought and feeling, are those which have the least generative power. To the objection that, in fact, civilized races are more numerous than others, Mr. Spencer answers that civilization, by diminishing a host of destructive forces, augments the means of subsistence, and thus maintains population at a superior figure; but the height of this figure is dependent on individuals having a greater faculty of conserving themselves, not on the species having a greater generative power.

The second law that regulates the multiplication of beings is, that richness of nutrition augments fecundity, while the expenditure produced by the exercise of the functions of relation, and chiefly the intellectual expenditure, diminishes it. Poor and badly-fed races are naturally the least prolific. The Irish seem to form an exception; but the increase in number among them is dependent on their marrying early (whence is derived a faster succession of generations), and on their improvidence in imposing no restraint upon themselves; in short, upon quite other causes than the generative force proper. Reciprocally, the increase of the vital expenditure, especially of the intellectual expenditure, tends to lower the degree of fecundity. This law still proceeds from the same principle: that what the individual acquires or expends on his own account and for the exercise of his own personal functions he can not transmit again by generation to other individuals.

It is certainly not proper to push the preceding biological inductions, the truth of which is only general, to extremes. Mr. Spencer himself has not always kept the measure or avoided inexact intepretations of the laws in question. Practically, and in the actual condition of affairs, the superior races and the individuals belonging to those races, do not lose their generative power except when they give themselves up to what we might call intellectual debauchery. But sterility rarely comes from this cause. Man can nearly always, even when he abandons himself to mental labors, maintain a procreative power fully equivalent to that of the woman with whom he is mated, and it is unreasonable to demand more of him. It is, then, the woman that must be considered, looking at the question from this point. Mr. Spencer remarks, in support of his thesis, that the women among the higher classes, in whom mental labor is carried to excess, are relatively infertile ; but there are also several elements to be distinguished here. The women of Paris have, for instance, a weight of brain which, according to the anthropologists, raises them but little above negresses : they should, then, by the theory we are considering, be very fertile, like the negresses ; but the contrary is the case. The real reason of this is, that while the brain of a Parisian woman is definitively but little overstocked with ideas, her whole body is still less developed than her brain ; but it is not so with the strong-limbed negresses. Why has the body of the Parisian woman been arrested in its development? Do not lay it to her intelligence, but to her want of intelligence, to costumes and fashion, to bad hygienic conditions, to parties, vigils, balls, and theatres ; to the activity, at the same time feverish and frivolous, of a wholly worldly life in an air more or less vitiated. In the same way, if the daughters of aristocratic families are relatively infertile, there is nothing to prove that their infertility arises from mental labor. In short, whenever mental labor is really a cause of diminished fertility, it is so by being excessive, and not by its well-regulated exercise. The same is the case with every excess of labor, even physical ; the common workman or laborer may exhaust himself as much as the thinker. Mr. Spencer has not sufficiently distinguished here between the normal and the exaggerated exercise of the brain. A normal exercise, in which the functional expenditure is not above the nutrition of the organs, but below it, does not appear to us to diminish fecundity, or, at least, does not diminish it enough to trammel the development of the species. In the normal individual, intellectual productivity and sexual productivity march in line ; they are, as it were, the two poles at which the excess of nutrition is expended after a right fashion ; but, in case one of the poles draws all to itself, it is evident that the other pole will lose correspondingly. The almost exclusive direction of an energetic nutrition toward a particular function results in the exaltation of that function and the depreciation of all the others; it might even create a kind of physiological monstrosity.

It is, then, the excessive and abnormal application of the brain that diminishes by compensation the generative vigor; and, still more, the bad hygienic conditions under which thinkers live, and, perhaps, the pressure of necessity, causing them to overwork themselves. Among the people who lead the march of civilization, the minorities who work excessively for the advancement of that civilization quickly exhaust themselves, and have to be replaced by new generations. This is the cause of the relative sterility of cities as compared with the fecundity of country places. The centers of intellectual life, the great cities, are, to M. Jacoby, the Minotaurs of civilization; but this is not only, as M. Jacoby seems to believe, because they think too much in the great cities, but because they think badly and live contrary to all the rules of hygiene. The biological law accepted by Mr. Spencer is true only in its most general principles, not in the extreme consequences which he has drawn from them, while special circumstances may intrude many a perturbation among the effects of the law.

In every case a time must come when equilibrium will at last be established. The nervous system will finally become capable of meeting, without being overcome, the difficulties of existence, and of supplying all usual demands. It will then cease to develop at the expense of the organism. By this very fact, fecundity will be normal, neither too great nor too little; and there will be harmony between the population and the conditions of existence. There is, then, truth in this final conclusion at which Mr. Spencer arrives: that the excess of fecundity has rendered the march of civilization inevitable (let us add the march of philanthropy), and the march of civilization should inevitably restore fecundity to its normal conditions. In this manner, perhaps, will be resolved the problem which troubled Malthus so much. In this way, also, we see that scientific philanthropy, by diffusing instruction along with well-being, and by raising the intellectual level of the needy classes, tends to establish among them the equilibrium of fecundity and of the intellectual functions, and consequently to diminish that blind and sometimes excessive proliferation which gives economists anxiety concerning the future, if not about the present. At this point, again, the advantages of philanthropy compensate, and more, for evils which involve nothing essential.

If it is important to establish in principle, as we have tried to do, the legitimacy and utility of philanthropy, it is not less necessary to fix the rules and limits of its application. An enlightened philanthropy should not bestow its benevolence at hazard and without conditions; it should be reparative and preventive justice together, instead of remaining that ancient "Christian charity" which, like love, too often has a bandage over its eyes. Now, reparative justice should endeavor to re-establish the normal conditions of human association, of the "social contract." These normal conditions require that the contracting parties or associates be really free and major. Society, then, ought to see that all minority, all servitude, all excess of inequality that may be produced by the fatal effect of the laws of nature or of the social laws, is suppressed or alleviated as much as possible. That is the general rule which should first be laid down. We pass now to its principal applications.

In the first place, what are the best means which philanthropy, or rather justice, has at its disposal in regard to the disinherited of life? In our view, they are education and work, not the traditional alms. Education can not be anything but useful; it tends to the development of intelligence, and is an aid that raises up, not an aid that depresses. By education, instead of favoring the propagation of imbeciles, we prepare more and more intelligent and capable generations. The bearing of education extends to all kinds of servitude and want, but principally to intellectual servitude and want, which are the origin of all the other kinds. Ignorance of the things most essential to social life, and even to private life, is the worst state of minority. It exists by nature in all children; it is kept up by the lack of instruction among poor children, and persists in the grown-up man. The effort of the state should be brought to bear especially upon this point, for it is the point at which all kinds of justice, defensive, preservative, and reparative, as well as real fraternity or philanthropy, converge and agree. Instruction is a matter of duty and right as of all toward all, and from all points of view; but, to speak only of the duty of reparation, in what way can it be exercised to better advantage, more pacifically, more conformably to the true interests and real rights of all classes, than by distributing knowledge widely among all? Instruction is the universal instrument of labor, useful for all professions, adapting itself flexibly to the most varied employments, an instrument which in virtue of this very fact helps us to find new resources when the usual ones fail. This general instrument of labor ought to be gratuitous; it ought to constitute a kind of moral capital distributed by all to every one. Furthermore, instruction is the only public assistance, or, if that is better, the only indemnity, the only public reparation, in applying which we do not risk sacrificing the interest and health of future generations to those of existing ones. The second means at the service of an enlightened philanthropy is work, which of itself can not be anything but useful: labor elevates the character as instruction elevates the mind; by compelling those to work who are capable, by giving to the less well-endowed tasks proportioned to their capacity, we may be doing something to raise the moral level.

To whom ought the benefactions of philanthropy to be addressed, and within what limits ought they to be restricted? In the first place, the child abandoned by its parents finds itself in one of those situations of major force and fatal servitude in which a member of society is incapable, unless he is assisted, of participating in the social life. In lifting up the orphan, society does not perform a work of mere charity, as those believe who speak of children brought up by charity; it simply performs a work of justice, not reparative only, but contractual justice. Shall we maintain that society has a right to let the foundling die, under the pretext that the support of children is the duty of the parents, and the parents are unknown? The most that can be said of such a conception is that it would be worthy of China and Japan. A society in the midst of which abandoned children may still be found is engaged toward such children by what the legists call a "quasi-contract"; it owes them food, with general and professional instruction, and in giving these to them it does nothing more than pay a general debt of reparative justice.* The same observation is applicable to the case of infirm old men, and, in general, of all persons who, being reduced to an absolute incapacity to work, have no parents who can support them; they also find themselves in a condition of minority and servitude which renders them incapable of taking care of themselves. A real moral right to assistance exists in these cases; in default of relatives, the duty of assistance falls upon the city; in default of the city, it falls upon the state; here is a point which legists, economists, and naturalists misconceive who see in public measures of relief an attempt on the liberty of individuals committed under the pretext of a charity that should be left free. Absolute liberty of charity is a religious and moral prejudice born of a defective analysis of rights.

Does society owe assistance only to those who are incapable of working, or does it owe it also to those who are capable but are exceptionally out of work, and thereby reduced to a condition of extreme misery—to a kind of temporary servitude and minority? The question is big with difficulties; it is one which has engendered too strong prepossessions to receive a scientific solution at the first view; and, between the contradictory exaggerations of the socialists and economists and the Darwinians, it still remains theoretically pending. We remark, in the beginning, that all countries, England, Germany, Sweden, etc., have recognized, whether right or wrong, a public duty to assist working-men. But they have not always taken the pains to limit the duty and give it a rational interpretation. The existence of the public duty of assistance can not confer upon the individual the right to demand work, either by force or by legal process. The state can not

* As much may be said of children "morally abandoned" and reduced to vagabondage. The public relief of the Seine, instead of shutting them up in a house of correction, from which they will come out corrupted, has, since 1881, placed them as apprentices in the departments. This measure needs to be completed by the passage of the bill for the protection of infancy, which was presented to the Senate on December 8, 1881.

engage itself, in a general and vague way, to give places or work to all who demand them, neither to the physician without patients, the advocate without causes, nor the poet without readers. It can no more make itself an ironmonger, a dealer in dress-goods, a furniture-manufacturer, or a house-decorator. In short, it can not substitute itself for the individual, artificially create work for him, nor artificially continue the production of any article, whenever a suspension reveals the fact that production has been excessive, and ought to be arrested. The merely moral right of the indigent engenders, in respect to this matter, only a moral duty on the part of society, a combined duty of reparative justice and fraternity. Since, moreover, the demands of every duty should be fulfilled, so far as is possible, society ought progressively to secure the satisfaction of them by the means which it shall judge best. But it can not grant its assistance to healthy individuals except under determined conditions and by a reciprocal convention. It is a case of a contract imposing mutual obligations, all the clauses of which ought to be settled with care. Here, more than anywhere else, the right to assistance is limited in a thousand ways, not only by the rights of personal property, but also by the real resources of the states, by practical impossibilities, and finally by the consequences that would follow if we should erect it into an absolute and positive right. It would in that case not stop short of self-destruction. We should recollect that, in the question of reciprocal rights and duties, we have to consider the future as well as the present. In this point of view, we can say in truth with the Malthusians and the Darwinians that the increase of sustenance would not follow the increase of population. As Malthus shows, an absurd consequence is implied in acknowledging an indefinite and unlimited right to assistance and to work; it is, that the funds destined to support labor can be made to grow at will, and that an order of government or a tax, like Elizabeth's tax, is all that is needed to bring this about. It would not be more unreasonable to order that two ears of corn shall grow where the earth has heretofore produced but one. Canute did not arrogate a greater power over the laws of nature when he prohibited the waves from touching his royal feet. To say that we ought to furnish work to all who only ask to work, is really to say, in other words, that the forces dedicated to labor, in any country, are infinite, that they are not subject to any variation, and that the ability to give work and good wages to the working classes ought to remain absolutely the same, without regard to whether the resources of the country are rapidly or slowly progressive, stationary, or retrograde.

This assertion, therefore, Malthus concludes, with reason, contradicts the most simple and most evident principles of the tender and the demand, and includes by implication the absurd proposition that a limited territory can feed an unlimited population. The question of assistance is inseparable from that of subsistence and population;

it is what we might call a bilateral question. The right to place children in the world is not a right merely individual and personal; there is in it an act that concerns not the parents alone, but all society as well. When the idle and careless call new beings into life, the task of feeding them falls back unjustly upon industrious and thrifty men. One does not have to take his children to the dispensary to put them in charge of society; the man who fills his house with children he can not support changes his house itself into a hospital, and that by his own authority, without consulting the convenience or considering the resources of any other one. The act involves an evident violation of stipulative justice. The state might, in such a case, say to the laborer: "You demand a promise of me, but are you disposed to give another one in exchange for it? My duty is correlative with your duty, and your right is not unconditional, but is subordinate to indispensable conditions. Will you give up the right of propagation? If you will, assistance is possible; if not, it is not, for you can not require those who have labored, produced, and saved, before you, to abstain from the enjoyment of the fruits of their labor till they have assured the support of all the beings whom it may be convenient for you or your descendants to call into existence." The procreation of children is not an act of individual whim, it is of the nature of a social act and of a contract. It is proper to have paternal and maternal duties determined by law. The false principle that every one has the right to procreate according to his fancy, without showing any more foresight than a brute, will eventually be rejected, says Stuart Mill, the same as the right of a merchant to buy and sell without keeping accounts is already rejected. To place children in the world without being able to support them will be regarded as a new kind of failure; it is, in fact, frequently more than a failure; it is a homicide by imprudence, because the children are destined to a certain misery and an almost certain death. All liberty involves responsibility.

Stuart Mill undoubtedly attaches too much importance to the legal regulation of population for the present time. In some countries, as in France, the population is now tending to diminish, rather than to increase too much. Furthermore, the bringing of American and Australian lands under cultivation assures subsistence to mankind for a long time, even if the population should increase rapidly. It nevertheless remains true that the relief given by the state can not be unlimited, and that assistance can not be erected into a right on which the individual can found a claim. Experience has shown us what kind of work we may look for out of the shops opened by public philanthropy. "When we do not give wages for work that we need," says Stuart Mill, "but give out work so as to furnish wages to those who need them, we may be sure that the work will not be worth what it costs." When we shall have no longer the power of dismissing the workmen, we shall not be able to get work except by the lash. Assistance to working-men is, then, still only a moral and general duty of the state.

We can not enter here into the detail of the economical or political reforms which would render the giving of assistance more sure and more effective by removing the inconveniences (moral and physical) of what is properly called charity ; we have only desired to show forth an ideal, and to give an apprehension of the difficulty no less than of the necessity of progressively attaining realization of it. The particular means by which the ideal is to be realized lie within the domain of applied sociology and politics. We merely indicate as among them the most perfect laws respecting property, the more equitable repartition of imposts, which should not be allowed to aggravate the *proletariat* by falling most heavily on the *proletaries* themselves ; a better application of the imposts ; the encouragement of institutions of credit, and of other means of credit less onerous than the *mons-de-piété ;* the establishment of intelligence-offices for workmen seeking work ; the extension of the system of mutual assurance on the initiative of the state and the communes, to a vast scale, in order to avert the most frequent and most grave material disasters ; colonies, removal to which should be the natural destination of every healthy citizen who has no trade or profession, and who, by begging, or a vagabond life, puts himself under suspicion ; and, lastly, the encouragement and increase of particular associations within the grand association of the state. Real benevolence is that which encourages, not idleness, improvidence, and the degeneration of the race, but labor, economy, and the moral and physical progress of generations.

"The state," says a writer who will be little suspected of socialism, M. Thiers, "ought to undertake to contrive means of preparation for panics. It may not be able to do all that could be asked of it, but with foresight it might do something, and even much, for the state has forts, machines, vessels, cordage, guns, cannons, wagons, harness, shoes, dresses, hats, cloth, linen, palaces, and churches to be made ; and a competent administration, which would reserve these works, so varied, for the times of panic, which should have for some articles, such as machines, arms, wagons, and cloths, establishments capable of being extended or contracted at will ; which should have designs for the strong places or the palaces it has to build prepared and kept ready for the seasons when the labors of private industry are suffering from interruption ; which should thus gather up upon the general market the unemployed arms as speculators buy depreciated public securities, which should add financial foresight to an administrative foresight of this kind, and should keep its floating debt free and disengaged, so that it could find money when no one had any—an administration which should take upon itself all of these difficult but not impossible cases, would succeed in greatly reducing distress without, however, suppressing it entirely. . . . Do not assert, then, that we must let the man without work die of hunger, for I contend that we can support him without giving him either wages equal to those of prosperous times, or wages that will allow him to become a mischief-maker or a soldier of the civil war."

The state concerns itself with the general interests of agriculture and commerce; with public works, the fine arts, posts, telegraphs, etc.; different ministries have been constituted for these ends; we believe there ought also to be a ministry of philanthropic institutions, charged with the duty of taking the initiative and creating foundations of this kind, with encouraging and aiding those that already exist, and with centralizing the efforts, gifts, and loans of individuals for philanthropic establishments. New organs should be provided, in the great body of the state, to answer to new needs. We now witness in this matter, especially in France, an absolute dispersion of forces, an anarchy, and faults in initiative and organization that impede all reform; if a special ministry existed for such questions, which seem not less important than those of the posts, commerce, and agriculture, the impulse would be quickly given. Loans, gifts, and legacies would permit the state to institute experiments under scientific methods or to aid those which might be made. Individuals do not, as a rule, care to bequeath their property to the state in general, for a general and neutral use; but how many persons would be glad to make gifts or legacies to philanthropic institutions! Religious congregations have a wonderful art of finding money for their works of benevolence; the state ought not to fold its arms and be indifferent as if it had no precise obligation in the matter. Foresight, public benevolence, and "fraternity," in our modern societies regulated by laws of increasing complexity, ought not to remain a kind of moral luxury wholly abandoned to the chances of individual inspiration. Charity is a general duty of justice, a work of science and not of mere sentiment, in which social economy and natural history ought to co-operate. In reality, the idea inspired by the labors of the Darwinian school on heredity and selection is, upon a final analysis, that of solidarity; and that is the very foundation of moral fraternity. Solidarity, doubtless, causes the miseries of one to fall upon the other members of the society, but it also extends the good fortune of each one to all and that of the mass to each one. By this very fact, it obliges society to find a remedy for every evil that afflicts the individual, because every such evil tends to become social. Solidarity limits our modern societies to the alternative of progress or dissolution. In the perfected machines which modern industry uses to weave linen, cotton, or wool, when a single thread breaks, the loom stops of itself, as if the whole had been informed of the accident that had befallen one of its parts, and could not continue its work till the breach is repaired. This is a type of the solidarity which is destined to reign more and more extensively in human society. In that social web in which all individual destinies intercross, it must come to pass that not a thread can be broken, not an individual can suffer, without the general mechanism being informed of the accident, affected by it, and forced to repair the damage as much as possible. This is the ideal which philanthropy is pursuing, and which it will approach more closely as it becomes more scientific in its method, without ceasing to be also generous in its inspirations.—*Translated from the Revue des Deux Mondes.*

[*Concluded.*]

THE SCHOOLS OF MEDICINE.

By R. O. BEARD, M. D.

NOTHING is so popular as prejudice, and no prejudice so popular as that resting upon a supposed scientific basis, or backed by reputed scientific authority. Always obstructive to the spirit of progress, it is peculiarly so when related to a subject so closely concerning the interest of the people as the study and treatment of disease. In these physically degenerate days the avoidance or remedy of the thousand "ills which flesh is heir to" is a question of well-nigh universal import. The urgency of this common need offers a partial reason for the adoption and perpetuation, by the public mind, of the differences which are supposed to exist between the two great schools of medicine; while, at the same time, it measures the greatness of the misfortune of the fact.

Rooted in the professional ignorance and bigotry of almost a century ago, fostered by the bitter rivalries and exclusivism of opposing theorists, these differences have been taken up and fed by popular opinion, until they seriously embarrass the progress of medical knowledge, and tend to destroy all faith in the science and art of healing.

The medical fraternity at large, and of both schools alike, is responsible for this unfortunate condition of affairs. When professional men, who, supposably, represent the best phases of liberal thought and scientific culture, lend their names to the partisanship of mere theory, and array themselves under sectarian titles which signify their adherence to an exclusive dogma, it is small wonder that the laity should follow in their footsteps, and cast their views into the yet narrower mold of unreasoning prejudice.

And, as professional hands have sown this seed of error, it is they who must gather its barren harvest, and uproot the tares of false opinion from the popular mind.

The recent agitation within the ranks of the one school of medicine, of the question of establishing consulting relations with duly qualified members of the other, presents a good opportunity of offering to the general reader a few facts which may serve to illumine existing error, and prepare the way for the appreciation of some generally unrecognized truths.

It may be safely asserted that the chief obstacle which the profession has to encounter, in the attempt to harmonize the hitherto conflicting systems of medicine, is the existence of so violent a prejudice among the people in favor of one school or the other that the doctor's income is liable to suffer as an effect of any concession to his liberal convictions.

When an unknown physician appears in any community, and solicits a share of public patronage, what does the inquiring public first demand to know concerning him? Does society take the measure of his social standing, or estimate the quality of his moral character and training? Do his prospective patients seek evidence of his professional ability, his special acquirements, or his general scientific culture? No. They submit him to no such crucial tests as these. They content themselves with asking the one grave question, "Is he allopath or homœopath?" and, having reply, assign him, according to their prejudices, to an immediate place in their mental register, as possibly useful or probably imbecile. What important principle, then, lies back of this oft-repeated query to account for its unfailing repetition? What significance is attached to these opposing terms, and whence is it derived?

In the first place, the words "homœopathy" and "allopathy" have a common authorship. The great founder and apostle of the homœopathic school, Dr. Hahnemann, was responsible for their coinage and introduction to the public. With the one, he proposed to christen the creed which embodied his own peculiar tenets; by the other, to throw into sharp contrast the system of the older and established school.

It is worthy of remark that his followers have, until recently, accepted, with singular uniformity, their leader's distinctive term, while his opponents have always, and with few exceptions, repudiated the name thus contemptuously bestowed upon them, and which has fastened itself to them through the influence of popular usage. The definition of these terms is somewhat obscure. Homœopathy does not now possess, *in toto*, its original significance. In its earlier day it represented a *group* of dogmas, which most of its younger disciples disown. Infinitesimal dosage, increased potency by means of dynamization, the unification of disease, etc., have ceased to be *essential* planks in the homœopathic platform. According to more recent interpretation, it may be defined as a system of medicine based upon the one theory, "*similia similibus curantur*," or the doctrine of a similarity existing between the physiological and the curative action of drugs.

Allopathy, on the other hand, may be said to mean—in so far as it means anything—the application of medicine upon the principle "*con-*

traria contrariis curantur," or a system founded upon the belief in a certain antagonism discoverable between drug-action and disease.

Upon the face of these definitions, seemingly irreconcilable differences exist between the two leading schools of medicine; differences which, if borne out by the *facts* of to-day, furnish ample excuse for this persistently anxious query of the public. That the present status, however, of medical science affords no adequate support to this popular idea of a hopeless variance is clearly susceptible of proof.

When Hahnemann promulgated his new and remarkable dogmas, they certainly came into direct collision with the then accepted opinions and practice of the medical world. They were conceived and brought forth in an age of heroic measures in medicine; an age, too, in which the sthenic types of disease were largely predominant, and when the lancet and its auxiliary depletives were accounted the unfailing panaceas of all human ills in which failure was not a foreordained fact.

The homœopathic tenets rushed to the other extreme of theory, and, in practice, won the faint praise of doing at least no *injury* to human life. But, starting thus from widely separated points, the two schools have steadily traveled forward along paths set in inevitably convergent lines. The unbridged space which lay between them a century ago has been narrowed imperceptibly in their onward march, until men discover with surprise that to-day, across the intervening chasm, they can safely join their hands; and that, by mutual approaches, they may soon walk side by side, in common effort for the relief of humanity, and yet keep steadily "abreast of truth." Unconsciously receiving the impress of its opponent's teachings, the older school has learned, first, to *lessen*, and then to *minimize* its doses; to improve the preparation of its drugs, and to seek for better forms and methods in their administration. If it can boast the direct salvation of no greater number of lives, in consequence, it is at least responsible for fewer deaths. Its distinguishing characteristics have ever been an active spirit of investigation, and the consequent widening of the limits of its medical faith.

The homœopathy of to-day has also shaken from its feet the dust of more than one worthless theory. Although within its ranks are still numbered some so-called "high dilutionists," its leaders have long ceased to insist upon infinitesimal dosage as an essential principle of treatment. Not a few of its representative men administer many of their drugs in crude form, as the rule rather than the exception of practice. If it still clings to its central dogma, its principal adherents no longer claim for it the respect or merit of a *universal law*. That it serves as a good indication for the use of certain drugs, in the treatment of many conditions of disease, few careful students of materia medica and therapeutics will deny. Witness, as instances, the physiological as related to the curative action, in some particulars, of arsenic, ipecacuanha, turpentine, nux vomica and its alkaloid, strychnia, and camphor. Explain the action in any way we choose—as substitutive, as the primary differing from the secondary effects of the drug, etc.—the relationship of similarity, however problematical its value, still remains.

Not seldom has the reproach been cast upon homœopathy that it possesses no literature worthy of the name; that its followers can boast no valuable discoveries or original research. In the main, the criticism is just. But, in this one department of medical science, the profession has received at its hands an incalculable benefit. It claims, and for the most part rightly, the credit of advancing, directly or indirectly, the study of the *physiological action* of drugs, as related to the alleviation and cure of disease. The careful experiments thus set on foot have thrown a light upon the selection and intelligent use of remedies which has largely revised the old system of therapeutics. Homœopathy has, undoubtedly, given to the world the revelation of more than one valuable truth, and the profession and people alike owe to it, in the persons of its advanced thinkers, the gratitude of respect and recognition. In short, as "every student is a debtor to his whole profession," so the schools of medicine are mutually beholden to each other. The same influences which have modified the one sect have served to liberalize both. The practical result, as already manifest, is of greater interest to the public than are the steps by which it has been reached. A careful study of the course of treatment commonly pursued by leading practitioners, and recommended by the highest authorities in the two schools, reveals the fact that, in *eighty* selected forms of disease, representing maladies of every type and every stage, six tenths of the remedies employed by these supposedly rival schools are identically the same in kind, and differ only in respect of dose. The variance is no greater than probably exists between the respective methods of practice of any two physicians of either school. Were disease an entity, and its types invariable, we might look for the establishment of a universal law of therapeutics; but, considering all the varying conditions of age, sex, temperament, habit, hereditary tendency, personal idiosyncrasy, climate, and general surroundings, it is, in the nature of things, impossible. Between homœopathic and "regular" physicians there is but one legitimate ground of quarrel—and herein the latter have sufficient cause of complaint—namely, the continuance, by their old-time opponents, of name and title suggestive of a rigid exclusivism, indicative of their supposed arrival at the *ultima Thule* of medical research, and their adherence to a universal dogma, to which, as such, they can no longer honestly adhere. Why should it not be possible for a guild of men, interested in so grand an object as the relief of suffering and the conservation of human life, to join cordial hands with their fellow-laborers in a common cause, and content themselves with the unequivocal name of *physician*, and the honored and honorable title of *Doctors in Medicine?* Let this once be *un fait accompli*, and we may rest assured that the good sense and mutual interests of the two great schools will speedily draw them together, in a process of mutual absorption, which will give a new impetus to the *growth of medical science*, and contribute immeasurably to a more successful, because more rational, treatment of disease.

The New York State Medical Society, representing the head and front of the profession in this country, has recently taken an initiatory step in this direction, by striking out and changing certain clauses of its ethical code which prohibited consultation with duly qualified homœopathic practitioners. Despite the unfortunate action of the American Association, in setting the stamp of their useless disapprobation upon this timely step, a thinking public must needs declare itself in approval of the New York Society. It has but constituted itself the vanguard of a movement which will soon be followed by all liberal men in the profession, and must ere long sweep away those petty obstacles to the progress of medicine, which, causing the disunion of its disciples, have limited its usefulness, weakened its experimental conclusions, and brought upon it the popular reproach of disagreement.

Many, it may be, of the older generation of physicians—minds which have crystallized unchangeably to the form of early ideas—must "pass away before these things are fulfilled," but they who are stepping forward to take their places in the great struggle with disease and death, will have their hands strengthened by a more conscious unity of work and purpose with their fellows, to which the profession of medicine has long been a stranger.

The principal barrier, let me repeat, to the attainment of this desired end lies, not within professional lines, but in the existence of this unfortunate prejudice among the people. When patients demand to be assured that a medical practitioner is—not an "allopath" or a "homœopath," but—a reputable and well-educated *physician*, then will the folly of "exclusivism" be made manifest, not alone to the *mind*, but to the *pocket* of the profession; and then will Medicine, unembarrassed by the strife of schools, rise to her possible place as a successful and a more *exact science.*

BRAIN-POWER IN EDUCATION.

WE are supposed to live in an age when brute-force has ceased to rule, and when brain-power alone is the governing agent. In the good old days, the heavy, strong-armed knight, protected by his impenetrable armor, and skilled in the use of his sword, was almost invincible. A little nearer our own day, the skilled swordsman or dead-shot whose ultimatum was the duel, ruled to a certain extent the society in which he moved. To test which was the most powerful knight was an easy matter; for a combat between the rivals was easily arranged, and the result was seldom questionable; or, if it were uncertain, the relative powers were supposed to be equal.

In the present day, however, the question of brain-power is a far more difficult problem. We can not weigh brains as we can tea or sugar; we can not determine their mental capacity as we could the physical powers of knights of old, by setting two of them opposite each other and leaving them to fight it out. We have, however, arranged various tests which we suppose give us a correct estimate of the brain-power of various individuals. These tests may be better than none at all, yet they are far from being perfect; consequently, we too often by such means select men to do work for which they are quite unsuited, and to fill offices for which they have no capacity.

The present is an age of competitive examinations, yet these afford but an imperfect test of brain-power; for, after a time, competitive examinations become less and less efficient as true tests of intelligence, and sink into a sort of official routine. As examples, we will take the following cases: Brown is the son of an Indian officer who died when his boy was ten years old, and left his widow badly off. Young Brown is intended for the Royal Military Academy, Woolwich; but his mother's means do not enable her to send him to a first-class "crammer's," so he has to sit beneath the average schoolmaster. He works hard and thinks a great deal, and gains a fair knowledge of the subjects he is required to learn. He goes up to the competitive examination at Woolwich, and finds each question so complicated that he is utterly puzzled; and, when the results of the examination are made known, Brown is nearly last on the list.

On the other hand, Smith is the son of a wealthy tradesman who wishes his son to enter as a cadet at Woolwich. Young Smith is sent early in life to a successful "crammer's," to be fattened with knowledge as turkeys are crammed for Christmas. The crammer does not confine his attention to teaching his pupils; but he watches the examination papers set at Woolwich, and he finds that the examiners have each a peculiar "fad," and set their questions in a sort of rotation. He looks carefully over these, and he forms a kind of estimate of the questions which are likely to be set at any particular examination. He therefore trains his pupils for these questions, and is often so successful in his predictions that at least half the questions have been worked out by these pupils a week before the examination; and this result is obtained without any collusion between the crammer and the examiner. On one occasion that we know of, seven questions out of a paper of thirteen were predicted as "due"; and the pupils consequently of this crammer were most successful at this "competitive." Young Smith is thus trained, and passes say fifth out of a long list, and is considered, as far as this test is concerned, to possess brain-power far beyond that of the unfortunate Brown, who was nearly last in this same examination.

Twenty years elapse, and Smith and Brown meet. Smith has jogged on in the usual routine; he may have never either said or done a foolish thing. Brown, on the other hand, is a man of wide reputation, has written clever books, and done many clever things; yet people who know his early history say how strange it was that he was so stupid when he was young, for he was ignominiously "spun" at Woolwich!

Those who thus speak imagine that the examination at which Smith succeeded and Brown failed was a test of their brain-power. It was in reality nothing of the kind; it was merely a test of the relative experience of those who trained Smith and Brown.

Even thus far it will be evident that our present supposed tests are not infallible; but we will go even further, and will examine the actual work itself which is supposed to be the great test of mental capacity, and we can divide this work into two classes—namely, acquired knowledge, and the power to reason. In nearly every case, the training which enables a youth to pass a competitive examination belongs to the first class—acquired knowledge. It consists of a knowledge of mathematical rules and formulæ, classics, modern languages, history, and geography. Mathematics, if properly taught, and especially geometry, tends to strengthen the mind and fit it to reason; but it too often happens that a youth is crammed with mathematics for a particular examination, and he has not mentally digested what he has thus been crammed with; and consequently, instead of his mind having been strengthened by this process, it has in reality become weakened; and ten or fifteen years after the examination, the man—then in his maturity—derives no advantage from his formerly acquired knowledge, because he has forgotten it. He merely suffers from the mental repletion of his younger days, and dislikes mathematics; just as a pastry-cook's boy is said to abhor tarts and buns, because he was crammed with them when he first was placed among such temptations.

A knowledge of modern languages is useful to those who travel, or who wish to become acquainted with the literature of other countries; but, as a test of brain-power, the acquisition of any language fails. There is no language in use which is based on anything but arbitrary rules; reason has no influence on languages. The selection in French, for example, of masculines and feminines, is most unreasonable. Why should a chair in French be given petticoats, and a stool placed in breeches? Why should the sun be considered masculine, and the moon feminine? In German, the same arbitrary rules exist—the masculines, feminines, and neuters have no reason to guide them. Take a child of five years old, and a clever man of twenty-five—let each use only the same exertion to acquire a knowledge of any spoken language, and the child will easily excel the man. This is because ear, and the memory derived from ear, are the means by which languages are acquired. Reason enables us to predict what is probable, when we know that which has previously occurred. If, then, we informed a reasoning individual that a chair, an article made of wood, with four legs, was feminine in French, and then called his attention to a stool, an article made of wood, with four legs, and inquired to what gender he considered the stool belonged, he would naturally conclude that it also was feminine; but a stool (*tabouret*) is masculine in French.

Then, again, the pronunciation of words is purely arbitrary. Take our own language, for example, and such words as plough, enough, cough, dough, bough, rough, etc. Where does reason enter into the pronunciation of such words? What power of intellect would enable us to pronounce "cough" correctly, even though we knew how "bough" was spoken? Yet, in spite of these unreasonable laws, classics and modern languages are not unusually referred to, not as stored knowledge, but as tests of mental power. As a rule, it is not the reasoner, or person gifted with great brain-power, who the most quickly learns a language, but the superficial thinker, gifted with ear; and these superficial people are the first to quiz any error made when a speaker attempts to converse in a foreign language.

We may fairly divide the subjects employed in modern mental training into those which store and those which strengthen the mind. Languages; a knowledge of history and geography; the *facts* connected with various sciences, such as chemistry, electricity, astronomy, etc., are stores; but not one of these does more than store the mind. Men's minds were stored with a certain number of astronomical facts when Galileo attempted to revive the olden belief that the earth rotated; but their minds had not been strengthened, as it was the leading astronomers who most offered opposition to him. Several men with stored minds were the great opponents of Stephenson when he talked about traveling twenty miles an hour on a railroad. So that it appears that, no matter how well a mind may be stored, if it is incapable of judging correctly on a novelty, it can not be called a strong mind.

Our competitive examinations tend almost entirely to bring to the front those whose minds are the best stored, and many persons therefore have come to the conclusion that by such a course we have obtained for our various services what are termed "the cleverest youths." It does not, however, follow that this result has been obtained. The greatest brain-power may actually be low down in the list of a competitive examination in which stored knowledge alone has been requisite. There is a certain advantage to be gained by storing the mind with facts, and some people imagine that a knowledge of these facts indicates an educated and strong mind. It, however, merely proves that the mind has been stored; it does not prove it to have been strengthened. We may know what Cæsar did under certain conditions; how Alfred the Great organized his police so that he could hang bracelets of value on sign-posts without fearing that highwaymen would steal them; and a multitude of other similar facts may have been stored in our minds; but any quantity of such stores would not enable an individual to solve the present Irish difficulty, unless he could find in the past an exactly similar case which had been treated successfully by some particular system.

It is even now considered that by making a boy pass through a long course of mathematics or classics, and then testing his acquired knowledge by an examination, we adopt the best method of obtaining the greatest brain-power. We *may* derive an advantage, supposing mathematics or classics are requisite in the future career of the boy; but, as a test of brain-power and perseverance, we would much sooner select the boy who could the most rapidly and most certainly solve a three-move chess problem. And, if mathematics are not required in the future career of a boy, it would be equally as unreasonable to devote three years to the solution of chess problems as it is to devote a like period to the solution of the higher branches of mathematics. In both instances, the mental exercise is supposed to be for the purpose of strengthening the mind, and the chess problems are certainly as efficient as the mathematical. It is not unusual to find a profound mathematician who is particularly dull in all other subjects, and who fails to comprehend any simple truth which can not be presented to him in a mathematical form; and, as there are a multitude of truths which can not be treated mathematically, a mere mathematician has but a limited orbit.

A chess-player, again, or a solver of chess problems, has always to deal with pieces of a constant value; thus, the knight, bishop, pawn, etc., are of constant values, so that his combinations are not so very varied. A whist-player, however, has in each hand not only cards which vary in value according to what is trump, but, during the play of the hand, the cards themselves vary in value; thus, a ten may, after one round of a suit, become the best card in that suit. Brain-power independent of stored knowledge is therefore more called into action by a game of whist than it is by mathematics, chess, or classics; consequently, while mathematicians and classical scholars may be found in multitudes, a really first-class whist-player is a rarity; and, if we required an accurate test of relative brain-power, we should be far more likely to obtain correct results by an examination in whist than we should by an examination in mathematics. In the latter, cramming might supply the place of intelligence; in the former, no amount of cramming could guard against one tenth of the conditions. A first-rate mathematician may on other subjects be stupid; a first-class whist-player is rarely if ever stupid on original matters requiring judgment.

A very large amount of the elements of success consists in the advantages with which an individual may start in life, and over which he himself may have no control. The case of Smith and Brown already referred to may serve to illustrate this fact. When conclusions are arrived at relative to hereditary genius, these advantages may be considered. The son of a judge becomes a judge, and we may claim hereditary genius as the cause. We should, however, be scarcely justified in assuming hereditary genius because the son of a general officer became this general's aide-de-camp. A general officer with five thousand efficient troops gains a complete victory over fifteen thousand indifferently armed savages, and he is looked upon as a hero. Another general with a like number of men is defeated by an army of ten thousand well-armed but unsoldier-like-looking men, and he is regarded as a failure ; and yet, of the two, the defeated army may have possessed the better general. In order, therefore, to judge of the relative powers of two individuals, we must take into consideration all the advantages or difficulties with which each starts in life, or in any undertaking. The relative success is by no means the only criterion from which to judge of capacity, any more than it would be correct to judge of the capacity of two whist-players, when one held four by honors and six trumps and his adversary held a necessarily poor hand.

In the great battle of life these conditions are perpetually interfering with the results to be derived from the relative value of brain-power, and are so numerous as to have an extensive influence. For example, a man possessing great brain-power has succeeded in attaining an official position of eminence. He selects a nephew or particular friend to be his assistant. We have competed with this assistant in various things, and there is no doubt as to his inferiority. Time goes on, and this assistant succeeds to the post of his relative merely from what may be called departmental claims, and he is *ex-officio* supposed to be possessed of the talents and knowledge which appertain to his post. Our opinion, if opposed to that of the official, will by the superficial outsiders be considered valueless ; yet ours may be correct, and that of our opponent erroneous. It is by such means that very feeble men often occupy official scientific positions to which they are by no means entitled in consequence of their intelligence.

When such an event occurs, an immense amount of damage is done to the cause of truth and real science, because the individual thus raised by personal interest to the position of a scientific judge or referee, too often fails to judge of a question on its merits, and condemns it if it be not in accordance with routine. A question thus disposed of is very difficult to again bring into notice without prejudice. There is no doubt that even among the so-termed educated people, the majority possess only stored minds, and are incapable, consequently, of reasoning on any problem, other than by bringing to bear on it their stock of knowledge which, probably, granting the problem is original, will not apply. No educated person doubts that the earth is a sphere; but few of these can prove that it is so by means of facts with which they are acquainted, though a simple law of geometry is able to prove the fact.

The average occupations of young men require nothing more than stored minds and powers of observation; consequently, our competitive examinations serve to some extent to bring to the front such qualifications. But it is not among such that we obtain our discoverers, inventors, great statesmen, or good generals. The mere routine man will almost invariably bring about a disaster when he has novel conditions to deal with; and as a rule the routine youth comes out best at an examination.

At the present time we have apparently no accurate test by which to measure the relative brain-power of individuals. Competitive examinations can not do so, for the reasons that we have stated. Success in life is, again, dependent on so many influences quite outside of the individual that this success is no test. The accumulation of money—that is "getting rich"—is too often but the results of selfishness and cruel bargains, and can not be invariably accepted as a proof of brain-power.

Considering these facts, therefore, it appears that just as intellect is invisible, so the relative power of intellect is unmeasurable; and instead of forming hasty conclusions as to the relative powers of two men, from the results of examinations, we may perceive that by such means we may be selecting those only who, under certain conditions, have succeeded in storing their minds with the facts required for that examination.—*Chambers's Journal.*

SKETCH OF HENRI MILNE-EDWARDS.

On the 3d of April, 1881, a medal, bought with the subscriptions of the scientific men and friends of science of various nations, was presented to M. Henri Milne-Edwards by a committee of representative French men of science, in honor of the completion of his great work on "Comparative Physiology and Anatomy." This magnificent treatise—of which M. Blanchard, in making one of the presentation speeches, said: "Many authors have, with more or less of success, published treatises for those who were studying; M. Milne-Edwards alone has made one for masters"—was the fitting consummation to which nearly sixty years of scientific labor had consistently led.

M. Milne-Edwards was born on the 23d of October, 1800, at Bruges, Belgium, of English parentage, his family having come from

Jamaica. After the invasion of Belgium, in 1814, the family removed to Paris, and established themselves there. M. Milne-Edwards studied medicine under the direction of his brother, William Edwards, author of a work on the influence of physical agents upon life, and afterward a member of the Institute, and was graduated as Bachelor in Letters in 1821, and Doctor of Medicine, at Paris, in 1823. In the latter year he presented several memoirs to the Academy of Sciences, among which was one on "The Influence of the Nervous System upon Digestion," which he prepared in conjunction with Breschet. In 1825 he published, in connection with Vavaseur, a "Manual of Materia Medica," of which a second edition appeared in 1828, and translations were made into English and German. His attention was afterward concentrated upon the zoölogical branches of science ; and from this time on the history of his life is a record of his researches and his publications in those branches, the briefest satisfactory account of which would fill the space of an article.

In 1826 he began, with V. Audouin, a long series of researches on the anatomy, physiology, and zoölogy of the marine animals of the French coasts, for the purposes of which he, either alone, or with his co-laborers, made several sojourns at different points on the sea-shore. Between 1826 and 1830 he thus explored in succession the coasts of Granville, of the Chaussey Islands, of St. Malo, Noirmontiers, and collected the materials for his work on "The Littoral of France," in two volumes, one of which is devoted to the history of the Annelids, and was the subject of a long report by Cuvier. In the beginning of 1827 he presented to the Academy a memoir which he had prepared, in connection with M. Audouin, on the circulation of the blood in the Crustacea, which received the prize in Experimental Physiology. His "Manual of Surgical Anatomy," published in the same year, was translated into Dutch and English. During a few years following he was engaged much of his time in chemical investigations in the laboratory of M. Dumas, whose pleasure it was, in making one of the speeches on the presentation of the medal, to speak of himself as the oldest of his friends and the closest witness of the labors by which his life was made illustrious.

In 1832 he was appointed Professor of Natural History in the Collége Henri IV, and Professor of Public Hygiene and Natural History in the Central School of Arts and Manufactures. In the next year he prepared the zoölogical part of an elementary work on natural history, by himself and Achille Comte. In 1834 he published his "Elements of Zoölogy," an elementary book on zoölogy for lyceums, which is included, with a "Botany" by Jussieu and a "Mineralogy" by Beudant, in the "Elementary Course of Natural History," and a general work on the Crustacea, in three large volumes and an atlas, the last volume of which appeared in 1836. It was while he was engaged upon this work—"which has become classic, and has been the point of departure for all the studies in that grand division of the animal kingdom" —that M. Blanchard became acquainted with him, and it was of this period of his career that that friend said, in his presentation speech: "At that time much was said of your discoveries on the organization of marine animals, and of your researches on the littoral of France. . . . Generally, naturalists have studied marine animals in the cabinet; you were of the opinion that it would be better to observe them on their domain, in the actions of their life. The learned world applauded."

In 1834 he made a journey to Algeria, and on his return presented to the Academy several memoirs on the marine animals of the African coast, and also one on the changes in the color of the chameleon. His researches on the Polyps, the results of which were published in 1838, were begun at this time, and continued with the co-operation of M. J. Haime.

In 1839 he published a work on the Ascidians, prepared after investigations at St. Vaast la Hogue and Nice, and passed several months at Roscoff in making observations on the blood-circulation of the Annelids. In 1841 he published a special work on the Acalephs, Spermatophores, Cephalopods, and Eolidians. In 1844 he went to Sicily with MM. de Quatrefages and E. Blanchard, on a mission the scientific results of which were embodied in a work in three volumes, the first of which contained the account of his studies on the circulation of the mollusks. On his return from this journey, he was appointed a professor in the Faculty of Sciences in Paris, in place of M. E. Geoffroy Saint-Hilaire, in a position to which he had already been inducted as a substitute in 1838, while he had also been appointed Professor of Natural History in the Museum, in place of V. Audouin, in 1841. It is of this period that M. Blanchard said in his eulogy: "You became professor in the Museum, and found me assistant naturalist to the chair to which all the votes designated you. I have forgotten nothing of that time from which nearly forty years now separate us. One thought ruled you, dear master, that of giving a strong impetus to our science. You excited to research by your example; by your counsel, you indicated to young naturalists the ways they should pursue. Desiring to make explorations in the warm parts of the Mediterranean littoral, you took M. de Quatrefages and myself to Sicily. We returned from there with a harvest. You brought a new light to science: you showed for the first time how certain vital functions are performed when the organic apparatus are still in a condition of relative imperfection. You were able in a short time to furnish a thousand proofs that the sign of the highest perfection of organisms is given by the division of physiological labor. You were still young, Monsieur Milne-Edwards, but you were already saluted as a master and recognized as a chief. Witnesses of that epoch, now becoming a little rare among us, recollect how, everywhere that science was in honor, interest was taken in the investigations on the organization of marine and inferior animals that were going on in our country. We had among us, in the course of a few years, the greater portion of the zoölogists, anatomists, and physiologists of the world. The first door at which they knocked was yours. At that fortunate period for science, your health was considered quite delicate. It has since appeared to all that your love for science gave you the strength which nature had refused you."

To these investigations succeeded his studies on the structure and classification of recent and fossil Polyps, and his monograph on British fossil corals, both prepared in connection with J. Haime (1848 to 1852), and in 1851 a series of memoirs on the morphology and classification of the Crustaceans (since collected in a volume of "Carcinological Miscellanies"). His "General Tendencies of Nature," which appeared in the same year, was on a subject which had occupied him for a long time; for his first publications on the vitality of the different parts of the animal organism, and on the law of the perfectionment of animated beings by the division of physiological labor, date from 1826, and were published in the "Classical Dictionary of Natural History." A monograph on the fossil Polyps of the Palæozoic formations, published also in 1851 in co-operation with M. J. Haime,, forms nearly the whole of the fifth volume of the "Archives of the Museum." Between 1857 and 1860 he published his "Natural History of the Corals Proper," and in 1858 a large volume on the "Recent Progress of Zoölogy in France."

The crowning work of his life, the "Lessons on the Comparative Anatomy and Physiology of Man and Animals," was begun in 1857, and was completed on the publication of the fourteenth volume, of five hundred pages, in 1880. This work includes all the lectures which were delivered by the author at the Museum of Natural History during the twenty-three years that it was in preparation. Professor Michael Foster said of this work, the "beautiful legacy," as Bernard has called it, of the venerable author, reviewing the ninth volume in 1870, in "Nature": "At a time when a 'differentiation' of study is carried to such an extent that many physiologists know very little about other animals than frogs, rabbits, dogs, and men, and many zoölogists have a very meager acquaintance with the results of experimental physiology, such a work as this, which skillfully weaves together all the main facts of animal biology, is most wholesome reading."

M. Milne-Edwards was nominated an officer of the Legion of Honor in 1847, and a commander in the same order in 1861. He received the Copley medal of the British Royal Society in 1856, and the Boerhaave medal of the Scientific Society of the Netherlands in 1880, being the first person upon whom that medal had been conferred.

M. de Quatrefages, addressing the subject of this sketch on the occasion of the presentation of the medal to him in 1881, said: "We present this medal to you in the name of the scientific men of the world. . . . All of us here recognize your merits; we all know why our appeal for homage to be given to you has been so widely answered. The first memoir you read to the Academy was in 1823. Since that time you have unceasingly continued to enlarge the field of science by your personal researches, and to teach, by speech or the pen, your rivals first, then the generations which grew up at your side. These labors, this teaching, then, have continued for nearly sixty years. And, to crown your work, you have collected into a single book the immense treasures of knowledge amassed by this long and noble labor. Your 'Lessons' present a complete picture of the past and present of the anatomical and physiological sciences, with their infinite details mebracing and co-ordinating general ideas, always as precise as elevated. The book marks a real epoch in the history of these sciences. It is from this time for us, it will be for our posterity, what the writings of Haller were for his contemporaries and for posterity. This is what even mere strangers to your habitual studies comprehend; and this is why we are authorized to present this medal to you in the name of the whole world."

M. Dumas said: "The Academy beholds in you the guardian of the noble traditions of the learned and the most authorized representative of French science. With passion for the truth, the boldness of a strong mind, and the prudence of a wise one, you have drawn a complete picture of life in all its aspects, as a consummate anatomist, as a sharp-sighted physiologist, as a physician, and as a skilled chemist. With you, physiology, in its highest and widest acceptation, has entered permanently into the study of the classification of beings. You have had the rare happiness, my dear friend, to begin young, to pursue in your maturity, and to terminate in the fullness of your vigor, a work which will remain a monument."

The list of his works, said M. Gaston Tissandier, in his notice of them in "La Nature," in May, 1881, "has not closed, for the eminent naturalist, in spite of his years, preserves all the ardor and activity of youth; without allowing himself rest, he consecrates all his efforts to scientific progress, offering one of the finest examples it is possible to cite of a magnificent career incessantly fertilized by labor and genius."

His son, M. A. Milne-Edwards, is pursuing the same course of research with the father, and displays in it the same characteristic activity and thoroughness.

CORRESPONDENCE.

THE BICYCLE CONTROVERSY IN STOCKBRIDGE.

Messrs. Editors:

ALTHOUGH the writer belongs to those inhabitants of the village of Stockbridge who are editorially stigmatized in the December number of your magazine as destitute of "moral backbone," as "openly immoral," and "barbarians," yet cowards and criminals have their rights at the bar of editorial as of other justice, and he asks you to permit him to file a plea to your indictment—in other words, to publish this answer to your strictures.

Sound criticism, quite as much as sound philosophy, you will agree, depends on a correct and complete statement of the facts. The following version of the bicycle controversy can be maintained by many witnesses. The writer asserts it to be in every material part substantially true.

The professor, whom you justly call distinguished, fresh from a victory in the Central Park of this city over the ladies, invalids, and children who had been accustomed to be pushed about the skating-rink on the sliding-chairs, which doubtless interfered with his essays in skating, and perhaps on abstruser matters, came to his country retreat in Stockbridge naturally confident of equal success in clearing out all bicycles from his path. He was accustomed to walk with his eyes downcast, *meditans nescio quid nugarum philosophicarum totus in illis*, and the necessity of keeping wide awake with his bodily eyes was annoying. There was no Park Commissioner and no "Century" or other social club where officials can be button-holed, and petitions granted *inter pocula;* but there were three selectmen, chosen to guard the interests of the town in the old fashioned New England way. He drew a petition, procured eighteen signatures, and presented it to them. Taking it as a fair indication of the sentiment of the town, the selectmen were on the point of granting it, when the application chanced to become known to one or two inhabitants who took a different view. A remonstrance was drawn, based on the facts that accidents more commonly occurred from bicycles frightening horses in the roadway than from permitting them on sidewalks; on the hardship of practically depriving children of all use of the bicycles; on the impolicy and injustice of subjecting summer fugitives from the cities to the same kind of restrictions they had fled from; and denying the existence or seriousness of the so-called accidents alleged in the petition. This remonstrance was signed by thirty-six persons. The signers were generally heads of families, and up to the moment of this act of turpitude were (with the exception of the present writer) persons of recognized standing and character. In consequence of this remonstrance, the selectmen decided to ignore the petition. The shrewd professor, then perceiving that though, by dint of that persistent persuasiveness in which he is unexcelled, he might collect signatures, yet that all the names remaining in the town could not outweigh the remonstrance, called on the person who prepared that paper and urged his assent to a second petition, which had already been signed by a considerable number of visitors and residents. This was a remarkable document. It began by renewing the prayer of the original petition; but the various signers had been permitted to incorporate in it their different views and prejudices, which gave it so motley an aspect that it was hard to determine what was the *net* application. It asked in one place that *all* bicycles be excluded from the sidewalks; in another, that they be so excluded excepting children's; in another, that bicycles exceeding thirty-six inches in diameter be so excluded; in another, that bells be required to be attached to all bicycles; and, in another, that no bicycle be allowed to go anywhere in the village faster than five miles an hour. The person of whom the request was made, though reiterating his opinion that the real and only serious danger of accidents in the village was from the frightening of horses in the road, yet being fond of peace, something of a "moral coward," and willing to see how a compromise would work, yielded to the professor's strenuous demand, and reluctantly signed a memorandum to the effect that he considered that the chief objection to an order excluding bicycles from the sidewalks would be removed by permitting children to ride them there. The multiform document, thus re-enforced, was thereupon taken to the other signers of the remonstrance, who, seeing the memorandum of their representative, signed also.

The wheels of the opposition being thus scotched, other signatures were then obtained, to the number no doubt correctly stated by your informant as a hundred and sixty-eight. Meantime, a moment's cool reflection out of the range of the professor's battery having convinced the first compromiser that he had made a mistake, he sent a note to the professor, requesting that his name might be removed. When the note was received at the professor's house, he was out, busily engaged in getting signatures. The next day he called on the repentant signer and informed him that, before the note was received, the document had been already presented to the selectmen.

These selectmen, though I maintain just and well selected, were puzzled. After discussing in open session the question whether a thirty-eight-inch bicycle ridden by a small boy should be compelled to take to the road, while big boys on thirty-six-inch bicycles were allowed to patrol the sidewalks, and the difficulties of enforcing regulations depending on the exact size of the bicycle, they decided, as the wisest practical course, to exclude all bicycles, in accordance with the original, principal, and most definite purpose of the petition. This decision, we believe, was a perfectly honest one. There was, at any rate, enough to justify it as such, and the burden is on those who charge dishonesty to prove it. It is true, as alleged, that this order necessarily "caused irritation." Why? Because it was unjust, or appeared so to the village. Yet this indiscriminate exclusion was the real object at which the professor aimed, and which he partly gave up only in order to make sure of as much restriction as he could get.

But the order was not generally satisfactory, and a counter-petition (which your informant seems to have forgotten) was drawn up and at once signed by about *two hundred* of those who favored the cause of the bicycles. The list included a great majority of the substantial names of the village, and was handed in long before anything like a complete canvass could be made, because the chairman of the Board of Selectmen was to leave town the next morning for a considerable absence, and immediate action was necessary. The selectmen held another session. Horses were frightened daily under the eyes of all by bicycles on the road. No accidents known to the community at large had resulted from the bicycles on the sidewalks. The decision of the magistrates was a responsible one in a pecuniary sense, as they might entail on the town heavy damages as the result of forcing the bicycles into the road, to the distress and dismay of the riding and driving public. Still, prompted by the desire which they throughout showed to act cautiously and fairly on a controverted point with which they professed no personal acquaintance, they made, in accordance with the general sentiment, a modified and, as the event seemed to prove, a judicious order. They excluded the bicycles within certain designated limits from the central and business part of the village, where alone they thought accidents likely to occur, but permitted them elsewhere on the sidewalk. From extreme caution they proceeded tentatively, however. The order was made about the middle of August, to remain in force till the 1st of September. This was for the purpose of testing its practical operation before establishing a rule at the expiration of the time limited. No accident happened. Nothing happened which the lenses of the learned professor could magnify into an "accident"; and on the 1st of September the order was indefinitely continued, with the like beneficent result.

Now, the selectmen are charged with "playing into the hands of an active party in favor of the boys." We will not stop to inquire who was this active party which overawed the selectmen and commanded a majority of the votes. But is not it hard on the selectmen, who did what they conceived their duty in the manner described above, to charge them with knavery, without, so far as appears, other grounds than that the order they finally made, in view of all the facts, was unsatisfactory to the professor? This is not Spencerian doctrine. If it is what the editor of this magazine calls a "vigorous canon of scientific method," it is rather too vigorous.

In the article in the "Springfield Republican," the accusations (according to the writer's recollection) are more bitter, and one of the magistrates is attacked by name. We shall come presently to the charge of Stockbridge special amenableness to Mr. Spencer's indictment against the American people. But here we may inquire whether there is no other fault found by him with our people, to which those are amenable who publish accusations against official persons for which there is no scintilla of proof. Mr. Spencer's ethics prohibit slander and personalities.

Now let us glance at the more general facts:

It will be admitted that bicyclists, like other domestic animals, have some rights which, once defined, are as much entitled to protection as the wider liberty allowed pedestrians. The question to decide is, at what point the exercise of these rights begins to turn into a trespass. It will hardly be denied that in the open country bicyclists may leave the rough road for the more traversable path which runs by it, and when the road and the path lead into a small, straggling village, where pedestrians are rare, the practice is still clearly permissible. When the road and path lead into a larger village, the road becomes paved or macadamized, and the path becomes a sidewalk, the question changes its aspect. In villages like Stockbridge, where there is plenty of space, and the broad, graveled sidewalks are never crowded, it is not a simple one. A good bicyclist can guide his machine almost around a blade of grass, and the great preponderance of accidents have resulted from bicycles encountering horses in the road. In large towns with thronged sidewalks, it is obvious that, whether bicycles are to be allowed in the road or not, they are in the way on the sidewalk, and ought not to be permitted there. A rule adapted to the compact English villages is not necessarily the best guide for ours. But it is not true that bicycles are not permitted on their sidewalks by any such general rule as the professor states. There, as here, the rule depends on the size of the village, and on the question whether such permission would or not be practically inconvenient. When the controversy in Stockbridge was going on, and rival posters were daily going up, considerable evidence was collected to this effect. In some villages, as in "Henley-on-Thames," the postmen travel altogether on bicycles, going freely on the sidewalks. In Massachusetts towns of about the size of Stockbridge, such as the neighboring villages of Lee and Barrington (which, by-the-way, are considerably larger than Stockbridge), and where there are no college professors, or, if there are, they reserve their perambulatory meditations for their return to their Poecilé, bicycles are generally permitted on the sidewalks. In much more populous towns, like Pittsfield and Springfield, they are doubtless excluded. Now, who is to decide when the permission to go on the sidewalk becomes a nuisance? Certainly, in this country, the people themselves, through their authorities. In New England these are the selectmen. New England almost if not quite alone retains the system of town self-government which for so many centuries preserved liberty and fostered civilization in Europe. The selectmen of a Berkshire village, charged with the supervision of the lives and property of the inhabitants, certainly have better means of judging and a stronger motive to judge rightly in what parts and places bicycles should be permitted within their jurisdiction, than a newspaper in Hampden County, or a magazine in New York City, acting on the *ex parte* statements of even a distinguished individual, who, having undertaken to have the question settled to suit himself, is indignant because the selectmen, in accordance with the expressed wish of a majority of those interested, have decided differently.

The writer is one of the professor's many admirers, and would be the last to impugn his good faith; but, once enlisted in a campaign, whether in behalf of science, charity, or some idiosyncrasy, he goes on with a persistency which is always indomitable and sometimes headlong; and he is apt to assume that his cause has but one side, which, in cases coming under the third of the above categories, at least, is not invariably true. In this instance, he threw aside the sketch-book with which it had been his wont to exercise his charming artistic talent during his vacation, and devoted his time to scouring and ransacking the by-ways and corners of the village for rumors and reports of accidents from bicycles, the existence of which, before they were seen or heard of by any one else, he was as satisfied of as Leverrier was of the existence of the planet Neptune before he saw it. He posted up from day to day notices of incidents more or less founded on fact, which he apotheosized into catastrophes. He went back over a period of four years, to the first introduction of the bicycle into the neighborhood, and the only genuine "accident" worth mentioning, it is believed, if his collection were dispassionately interpreted, was the result of the fall, on a baby-carriage, of a bicycle unskillfully mounted by a learner at this early day. People saw with wonder lists of tragedies posted in front of the post-office which no one had heard of, and which were the more mysterious as they were generally without date, and the sufferers were commonly designated as Mr., Mrs., or Miss Blank, or the infant child of Mr. and Mrs. Blank. Why had no one heard of these terrible things? Why were not half of us in mourning or in tears? What right had we to walk erect on unbroken legs while so many were mangled? It seemed as if a wholesale slaughter had been going on in the midst of us without our knowledge. Fortunately, a little inquiry into the facts soon dissipated our apprehensions.

Let me illustrate: the writer, while looking at the list of casualties with feelings fortunately for him not quite akin to those with which we used to devour the returns from the Chickahominy, read somewhat as follows (the number and the precise words are not remembered, but the substance of the bulletins is correctly given): "No. 16. The infant child of Mrs. Blank run over and badly injured by a bicycle. For particulars refer to J. O. R., Esq." Looking further the writer read as follows: "No. 21, J. O. R., Esq., run into and hurt by a bicycle." (J. O. R. was the same person referred to in No. 16.) It so happened that the writer observed at the moment in the post-office J. O. R., Esq., himself, and improved this opportunity by inquiring of him the particulars of the two calamities, calling his attention to the alarming record before us. "Well," said he at last, "that isn't exactly right. I didn't see anything happen to any child, and I haven't been run into myself, but I understood that old Mr. J. G. had been run into and hurt." Soon after this conversation, the writer chanced to meet the wife of the old gentleman in question, and said to her he was very sorry to hear that her husband had been run into by a bicycle, and hoped it was nothing serious. "Why, no," said she, "he was not actually run into, but you know he is quite infirm, and a bicycle came very near him and he was a good deal alarmed lest it might hit him." This was the residuum from the analysis of the two accidents. A list of burlesque "*escapes*" was posted from day to day by the side of that of the so-called "*accidents*," and about equal credence was given to each. Both were worthy of "Patience," or the "*Belle Hélène*." To the annoyance of both parties, the selectmen at last impartially took down both sets of notices, not because of any improper motives as charged, but because of the crowd which gathered daily in front of the post-office so thickly as to become a nuisance. The professor was laughed out of court; and we villagers, while all conceding his excellence and genius, think him daft on the bicycle question. The real bullying was all done by him, though unconsciously; and the real "cowards" were those who, like the writer, under the glare of those wonderful eyes, had not dared to refuse to sign his pieced and patched compromise petition.

In sooth, this particular charge of moral cowardice in the Stockbridge people is unfounded and ridiculous. Not only were there no accidents deserving the name, but none were likely to occur on the sidewalk, which might not be avoided by that reasonable circumspection which the law expects from every one, and the want of which would precipitate a misfortune from a post or a wheelbarrow equally with a bicycle. The names attached to the bicycle-petition were signed because of the deliberate conviction that the danger from frightened horses was greater than from bicycles on the sidewalks. Horses in the country do not all get accustomed to these Centaur-like appearances, as those in the city do to corresponding monsters, such as the elevated trains, because different horses come into the village daily from the surrounding region. These animals standing on their hind legs, or rushing and shying, were frequent occurrences, whereas an unskilled bicycle-rider on the sidewalk can be avoided, and a skilled one can always avoid the pedestrian.

It is now, we hope, made apparent that Stockbridge barbarism has been prematurely assumed on *ex parte* testimony. Until a law should be passed to the contrary, the wide sidewalks away from the crowded part of the town were rightfully free to baby-carriages, children's wagons, wheelbarrows, and bicycles, and in the present state of the population there seem to have been good reasons why there should be no such law. At least, enough has been said to show that "the community" does *not* "acknowledge the outrage," and that the reason why the gentleman in question was "not supported but was condemned for his action" was, that it was reasonably regarded as an unwise and unnecessary attempt to curtail those rural privileges which citizens commorant in the country as well as the villagers themselves regard as a great charm of their summer.

Inaccurate "data" and the proposal of unnecessary legislation come strangely from the disciples of Herbert Spencer. Strange, too, would it be if they were nearer the "barbarism" of their master's code than the orderly lovers of freedom whom they denounce. "Infinite presumption is discernible in this attempt at regulating the doings of men by law. . . . The desire to command is essentially a barbarous desire" (Spencer's "Social Statics," pp. 321, 80).

The length of this communication may seem monstrous. But the writer has been long-suffering. As a lover of peace, he had allowed the printed circular distributed throughout the village, which contained the same one-sided version of facts on which your article is based, as well as the impertinent and libelous attack in the "Springfield Republican," to go unanswered. For the good fame of Stockbridge, at which the professor, while leaving it for some years, it is understood, as a residence, aims through the editor of "The Popular Science Monthly" this Parthian shot, I could hardly say less. But, unless some astonishing twisting or suppression of material facts compel a further statement, I shall not again ask permission to trespass on your interesting columns.

VERMICULUS OBTRITUS.

NEW YORK, *December* 22, 1882.

EDITOR'S TABLE.

MACHINE EDUCATION.

WE hear much of the bad effects of machine politics, but it is questionable if the evils of machine education are not far worse. By machine education, we mean the rigid, mechanical, law-established routine applied to great multitudes of children of all conceivable sorts who are got together in large establishments and submitted to operations that go under the name of mental cultivation. Machine education is of the very lowest sort, and the best that can be said of it is, that it is barely better than nothing at all. The worst difficulty is, that it is not capable of improvement. The method itself is radically false, so that the improvements of it but make it worse. At the same time it borrows influence from its enormous extension and the authority by which it is enforced. The education-factories run in series, each has a complex grading, and the different institutions are intimately belted with each other, and all driven by the motive power of legislation. As might be expected, the whole system is run with a view to popular effect, which is necessarily fatal to the best results.

If the reader will refresh his memory in regard to the first principles of mental cultivation by reading the article, found elsewhere in our pages, entitled "Brain-Power in Education," he will get a clear idea of what must be the necessary outcome of educational mechanics. In the work of the school there are two modes of dealing with the brain; it can be stored with information, or strengthened in its functional operations. True education consists in the development of brain-power in accordance with the laws of its activity, and is simply and always a discipline in spontaneous self-exertion. In the attainment of this object the engineer of the educational machine has very little to do. The office of the teacher is important, but it consists in encouraging, inciting, and arousing the pupil to put forth his own efforts, and when this is most effectually done the result is not of that conspicuous kind that is suitable to make a showy impression at a public parade. No method has yet been devised for exhibiting such results that is not full of rank injustice and that does not put a premium upon inferior work.

But it is wholly different when the object is simply to store the brain. This is an easy process, depending upon external appliances and mechanical arrangements, and is capable of being so organized and driven that a shallow and vicious system shall win the highest public applause. As the article referred to explains, it is impossible to get indexes of the hardest brain-work that are fitted to astonish gaping outsiders; but, when it is a question of merely stuffing with acquisitions, nothing is easier than to invent methods by which the results may be strikingly displayed. Hence the marking system which professes to indicate degrees of proficiency and educational results, and which gives so much business to teachers, examiners, inspectors, and superintendents, and enables them to report to boards of control, to parents, and to the public the wonderful success of the institution. This is machine education in its perfection, and the worst of it is, that it excludes the possibility of rational education. The two things are incompatible, for that which can be shown with effect is sure to take precedence of that which can not be exhibited, and brain-storing will proceed at the expense of the self-activity by which mental power is alone acquired. The subjects, moreover, that are most favorable to storing will take the lead and come to be fundamental in machine education. The whole mechanism of the public-school system is now impelled by law in this bad direction. The higher schools react upon the lower, to stimulate the method. Competition for promotion fires the vanity of the pupils, and parental influence conspires to heighten the result.

A new confirmation of this bad state of things has been recently elicited by the New York "Mail and Express," which has started a little inquest of its own into the working of the public schools. A reporter was sent to question the different teachers and officials on various points, and the information he obtained is useful as illustrating the vigorous action of our educational machinery upon one hundred and twenty-five thousand pupils. The Superintendent of the Schools of New York said to the reporter:

"My assistants are instructed to visit the schools, and in their examinations to find out what the children know and how well they know it. *They examine in nothing but the branches prescribed by law to be taught, and in each grade only in the work allotted by law to that grade.*" Again he says: "In my last annual report you will find that, out of twenty-six hundred and ninety classes examined, eighteen hundred and twenty-seven were marked 'Excellent,' and eight hundred and nineteen 'Good,' and only forty-four as 'Not commendable.'" This is of course the kind of result that officials are interested in making, as it naturally brings public commendation, more ample appropriations, and larger salaries. By the very nature of the case, therefore, they will be disposed to favor all those injurious agencies which co-operate to heighten the effect. To illustrate how despotically this bad system works, and how completely all who act under it are but parts of it, listen again to the New York Superintendent: "It is my business to stand between teacher and examiner, principal and teacher, teacher and scholar, parent and teacher, and protect all in their rights. But as to permitting teachers or principals to dictate what questions shall be asked or how they shall be asked, and what marks shall be given—that would be equivalent to resigning my office and handing over the direction of the schools to them, something which I do not propose to do." Thus in machine education the dictation is of course official—those who are in closest relation with individual requirements being allowed no discretion.

President Hunter, of the Normal College, applauds the subjects and courses of study which lend themselves to the smooth working of the machinery by numerical percentage scales of proficiency, on which pupils are promoted from grade to grade, and from lower to higher institutions; but he does not deny that the marking system has some faults; he says: "That some of the pupils of the higher grammar-grades are overworked in preparing for the college, is undeniable; but the fault lies not in the course of study which the board has prescribed, nor in the methods pursued in working out that course, but in the ambition of parents to have their children rapidly advanced, and in the desire of the pupils themselves to obtain high marks."

But where, by the working of the great machine itself, the pupils are set to racing for the Normal College, and to racing for the College of the City of New York, what else can be expected? The honors are but a premium for overdriving in the direction of such acquisitions as make the best show in examination, and win the highest percentage of marks.

President Hunter also naïvely observes: "Many of the evils complained of in the present system would be remedied by allowing each teacher half an hour a day to show the pupils how to study." Verily, verily, the machine must be in perfection where this is impossible.

Mr. Commissioner Crawford admits that the New York schools were once quite imperfect, but that "now there are, generally speaking, no poor schools. There is a general uniformity of excellence. There is a greater unity, greater harmony, a higher level in teaching power. Then supervision was not so minute as at present. Now we have, perhaps, too much supervision, but the committee have endeavored in this report, and the superintendent is all the while trying, to ease up the machine." The ideal of education here implied, that of unity, uniformity, and harmony in the external working of the system, shows how completely the State machine has superseded the older method by which the teachers had some liberty to adapt themselves to the fundamental though ever-varying requirements of individual pupils. It is the characteristic of machine education that in its working the individual disappears.

No doubt we are talking treason against the State, and blasphemy against a popular idol; nevertheless, there are many who hold that in education, as in politics, the sooner the machine is "smashed" the better. If practice in chess and whist would give a better education than the machine, it is time to protest. Our most thoughtful educators are revolting against the predominant method, which, having been adopted by the State as best suited for official management, is extending throughout the nation. But many, as we said, are striking out, and demanding a good deal more liberty in school management. They condemn the pernicious mechanics of the schools just in proportion to its perfection. Colonel Parker, for example, is one of those who demand more freedom in the play of educational agencies, and more attention to the kind of work that is least available for display. He is recently represented as saying that "uniformity in schools is death"; he does not believe in "per cents," he would not have them in schools under any circumstances: "Here is a child who is not so quick mentally as another; he studies as hard and labors as faithfully as the others, but, not being able to advance so rapidly, he is marked fifty per cent, while others walk off waving their ninety-five per cent in triumph. It is discouraging to the moderately dull child, and wrong. If a child is examined and asked the name of a river, and can not answer, off goes five per cent."

The difficulty of machine education is, that under it pupils are not taught to think for themselves. It can not educate the judgment, or prepare the mind to meet emergencies through the practice of self-reliance. As remarked by a teacher, "The public-school scholars are excellent in the line of their drill, but, take them one inch outside of it, and they are lost."

BICYCLES AND CIVILIZATION.

We give space to a long communication on the bicycle controversy at Stockbridge, replying to our article upon the subject two months ago. The writer makes many explanations, and indulges freely in sarcastic personalities; but the reader who cares to compare his letter with what we said will probably observe that the facts of the case remain substantially as we stated them, while everybody can judge as to the correctness of the conclusions drawn from them. To the local particulars of the Stockbridge war we can give no more attention, but will say a few further words on the general aspect of the subject.

We assumed in our former article that large bicycles run upon the sidewalks are objectionable. The sidewalks are a portion of the highway reserved for pedestrians, made smooth and hard to facilitate walking, and protected from exposure to accidents by street vehicles. A new wheeled vehicle is introduced of a peculiar character, but which belongs, if anywhere, to that part of the street which is usually devoted to vehicles. Thus far these new vehicles are only in a very small degree subservient to any use or necessity, public or private, but are run mainly for the pleasure of their riders. These are mostly boys seeking their amusement, and, as the machine is somewhat expensive, only a comparatively few boys are able to possess them. Probably there were not more than half a dozen boys with large bicycles in Stockbridge. They take to the sidewalk because they are objected to in the street, and because the wheeling is nicer. They run swiftly, and when under high motion can not be quickly stopped. That their movements are disagreeable to pedestrians is inevitable. They are sources of constant anxiety and apprehension to them. Accidents have occurred with them, and they are continually liable to occur. The sidewalk belongs to the community, and is indispensable to the daily uses and necessities of all classes of people. Everybody has the right to walk there without molestation or the apprehension of molestation. Nothing should be permitted there which will awaken the dread of danger and compel the pedestrian to be constantly on the lookout to protect himself. Our correspondent says that they can be easily avoided, but how can a bicycle coming noiselessly from behind be avoided? They have India-rubber tires, and people have no eyes in the backs of their heads. But it is by no means a question what people with their senses about them can do if they give all their attention to personal security. The instinct of self-preservation does, of course, save the mass of people from being run down by bicycles when exposed to them. But is it right to introduce an extra exposure of this kind on a public sidewalk that will keep the sense of personal solicitude against danger constantly uppermost in consciousness? Besides, all people are not vigilant in such matters; many are heedless and stupid, and others abstracted or absent-minded. Then, again, there are the children, the aged and infirm, the invalids, the deaf, the cripples, the blind, and the half-blind, and these constitute a very large proportion of those who use the sidewalks, and have a right to use them without annoyance. To all these people the large bicycles ridden by sporting boys are a constant source of fear and dread, a pest of the pathway, and an undoubted nuisance.

We are here speaking of the rights of pedestrians on a common-sense view of the case. But our correspondent says, "It will be admitted that bicyclists, like other domestic animals, have some rights, which, once defined, are as much entitled to protection as the wider liberty allowed pedestrians." Admitted, of course, the only question being on the definition. We have contended negatively that the riders of large bicycles have no right upon the sidewalks, any more than equestrians, but this is not a denial of all rights. What, then, do the bicyclists themselves maintain? They assert that the bicycle is a wheeled carriage, and its rights simply the common rights of carriages upon the street. The representatives of the bicycle associations in New York claim that their right is to the use of the highway, and they explicitly disclaim any right to the use of the sidewalk.

W. R. Pitman, captain of the Ixion Bicycle Club, on being asked his opinion as to the propriety of bicycles being ridden on the sidewalks of small villages, said emphatically that "bicycles had no business on sidewalks *anywhere;* that the sidewalks were meant for foot-passengers and not for carriages, which the bicyclers claim their machines to be."

Dr. N. M. Beckwith, captain of the Citizens' Bicycle Club, said that in his opinion bicyclers had no right to sidewalks at all, and remarked that the bicyclers wished to have their machines regarded as carriages, and claimed all the rights and privileges given to carriages, and in so doing they certainly could not also wish to be looked upon as foot-passengers.

Charles A. Reed, captain of the Columbia College Bicycle Club, said that he thought bicycles had no right on sidewalks or foot-paths except when the road was utterly impassable to them, and that a bicycle could certainly be ridden wherever a light buggy could be driven.

Extensive dealers have expressed themselves to similar effect. The Bicycle Union of Great Britain, in its recommendations regarding road-riding, said, "It is desirable that a rider should at all times keep to the left-hand side of the road, even if no vehicle be in sight, and riding on the footway should never be resorted to." (Pope's "Manual," p. 128.)

The circumstances in which it is admissible for bicycles to deviate into the foot-path are thus stated in "The American Bicycle," p. 122: "As to riding on foot-paths and sidewalks, it may be said that bicyclers, like travelers generally, have not only a right to travel in the highway, but they have a right to a passage along the highway, notwithstanding obstructions; and, if the middle of the road be impassable for their carriage, the side may be taken; and, if the whole roadway—including foot-paths—be impassable, they even have a right to turn out upon the abutting close, and pass over private land around the obstruction, provided they can do so without committing irreparable or very incommensurate damage. So that if, in suburban streets or country roads, the carriage-track is in so bad a condition as to be difficult or impossible of passage by a bicycle, and the foot-path can be taken without imminent risk to foot-passers at the time, it is justifiable for the bicycler to take it." The bicycle authorities are thus in full agreement with common sense.

And now about the impeachment of "the good name of Stockbridge." That lovely village, through its constituted authorities, and after due deliberation, decreed that such a nuisance as bicycles upon the sidewalks shall be tolerated. Is it not fair to take this fact as a measure of its moral status, and its grade in the scale of social progress? We were taught many years ago, in "Woodbridge's Geography," that communities of men are ranked as savage, barbarous, half-civilized, civilized, and enlightened. Any such classification is misleading which implies a stratification or a definite gradation of societies, so that one shall belong altogether at the bottom, and another at the top. The thing is much more mixed. There are savage streaks running through civilization, and enlightenment often coexists with barbarism. Society does not improve in all things alike. Every advanced community retains vestiges of its primitive lower condition. We gave Stockbridge credit for a large complement of virtues and excellences, but Stockbridge has proved herself to be no exception to the common law which gives rise to social anomalies. It has plenty of culture, intelligence, refinement, and religion; but, in common with many other highly cultivated communities, it betrays elements which are characteristic of the inferior grades of society. The ideal virtue of any community, its highest attainment, is justice. There is knowledge enough. People know well enough what is right, but in the undeveloped character conscience does not rule the actions. That is to be a matter of future evolution; and, meantime, we are concerned with the relative attainments of different societies in this respect. The sense of justice is so dull in Stockbridge that it is measured by the selfishness of a small group of boys. What those boys want for their personal gratification must be conceded, no matter what inconvenience to others stands in the way. What the standard of justice is among boys is pretty generally understood. The moral sentiments are the last to ripen in the growth of character, and the immature man has about him a good deal of the barbarian. Boys are thoughtless, selfish, uncompassionate, and often cruel. They delight to worry the cats, to stone the dogs, to plague their sisters, and fight each other. College practices and outbreaks often indicate the immaturity of youthful moral sense. The boys taught the forms of civility, and that it is good manners to defer to others, but unless morally precocious they are not gentle men. That they should be indifferent at annoying and distressing people on the sidewalk with their bicycles is but natural. But as boys they are more than inconsiderate, and, if they did not run down old women, would enjoy scaring them. We, however, find little fault with the Stockbridge boys. But they need discipline in the recognition of mutual rights as well as indulgence for their pastimes, and the community which allows them to pursue their gratifications at the expense of the comfort of their neighbors is in that respect and to that degree—well —not in the highest degree civilized.

BAIN ON UNIVERSITY EDUCATION.

The brief history of the higher education contained in the Rectoral Address of Dr. Bain at Aberdeen on "The University Ideal," which is herewith printed, will interest all thoughtful readers. It will prove chiefly interesting as a compact review of changing university methods during the rise of modern knowledge, and a statement of the present status of the university in the exigencies of modern life. As regards modes of teaching, the type of the university which has grown up within the last hundred years is based upon the principle of the division of labor by which men specially qualified for the work are especially intrusted with the subjects they have mastered. Obvious as this principle is to us, and difficult as it is for us to conceive how the higher education could stand upon any other principle, yet the present method is but the product of centuries of struggle before this policy could be established. It is undoubtedly a result of that general progress of science which can not be said to have got its initiation in the older university methods. With the division of labor in teaching comes the new aim of the higher schools of learning. "Its watchword is progress, and there can not be progress without a sincere and single eye to the truth. The fatal sterility of the middle ages, and of our first and second university periods, had to do with the mistake of gagging men's mouths and dictating all their conclusions. Things came to be so arranged that contradictory views ran side by side like opposing electric currents, the thick wrappage of ingenious phraseology arresting the destructive discharge. There was, indeed, an elaborate and pretentious logic supplied by Aristotle and emended Bacon; what was still wanted was a taste of the logic of freedom."

Dr. Bain insists that the bearing of modern science upon the higher education creates the demand for three fundamental elements in any adequate university curriculum, and he maintains that Aberdeen University holds the leading place in having recognized these elements for the past hundred years. He says: "Our curriculum is one of the completest in the country, or perhaps anywhere. By the happy thought of the Senatus of Marischal College, in 1753, you have a fundamental class not existing in the other colleges. You have a fair representation of the three great lines of science—the abstract, the experimental, and the classifying. When it is a general education that you are thinking of, every scheme of option is imperfect that does not provide for such three-sided cultivation of our reasoning powers. A larger quantity of one will no more serve for the absence of the rest than a double covering of one part of the body will enable another part to be left bare."

LITERARY NOTICES.

Ragnarok: The Age of Fire and Gravel. By Ignatius Donnelly, author of "Atlantis: the Antediluvian World." Illustrated. D. Appleton & Co. Pp. 452. Price, $2.

This must rank, we suppose, as a book of science, though it is of a quite peculiar kind. It is something like what one of Jules Verne's books would be if that author should stoutly protest that the story was all true. The author put forth a work not long since, entitled "Atlantis: the Antediluvian World," in which he maintained that there is a good deal more truth than poetry about the old story of the fabled island. The book was readable and popular; and, encouraged by its success, he has now struck out more boldly, and given us in "Ragnarok" perhaps the most stunning and stupendous romance of science that has ever been perpetrated.

Opinions will be divided as to whether the author is practicing upon public credulity by an enormous joke, or whether he does not really himself half believe half that he says. He is probably a lawyer, and at all events a politician; and it would, therefore, not be fair to him to raise any question of the sincerity of his views. Nor is it at all important how this point is regarded by the reader, for this is just the peculiar kind of science that escapes all perplexing and stupid inquiry about its truth.

The work is geological, astronomic, and religious, because it falls back upon these three subjects for the materials of the author's theory. This theory has two aspects, a negative and critical, and a positive and constructive aspect. It first maintains that the loose materials of the earth's surface—gravel, pebbles, stones, sand, clay, bowlders, and the miscellaneous mineral stuff which makes up the drift or diluvial deposits upon the earth's surface—are not derived from the rocks that make up the earth's crust, as taught by geology. The author has read over all the geological treatises and speculations on the origin of these superficial formations, and devotes his first eight chapters to a very ingenious presentation of the insufficiency of all existing theories upon the subject. Evidently knowing little about it himself, in the real sense of *knowing* (that is, as a first-hand observer of facts), and addressing an audience in a quite similar state of mind, he has no difficulty in making out a wonderfully plausible case. If the experts in "evidence" can often convict innocent men and get scoundrels acquitted in the very teeth of opposing representations, it is easy to get up a telling case where there are many gaps and discrepancies in our knowledge of a new, extensive, and very complex subject.

Having thus impeached the geologists, our author has a clear field. If the loose mineral materials under our feet are not from the rocks, then pray where do they come from? The human intellect can not stand still, as if struck with paralysis, and wait forever for the geologists to settle their disputes; we must have an answer, and be at peace. Mr. Donnelly then proceeds to supply the answer. He here strikes off into astronomy, and maintains that this mineral *débris* is of meteoric origin. Stones are known to fall from the heavens, and spectrum analysis proves that the celestial bodies are composed of the same mineral constituents that are found upon the earth. There being, as old Kepler says, more comets in the heavens than fishes in the sea, and their movements being so apparently capricious and irregular that they dash about through the solar system with the greatest liability of striking its steady-going members, it is maintained that the earthly drift has been dropped upon this globe by one of these incontinent wanderers, as, perhaps, the earth went through its tail.

The author propounds this idea as an hypothesis, insufficient it may be at first blush, but admissible when all others have broken down. But he does not by any means leave the question in this speculative condition; he proceeds to summon the proofs that his hypothesis must take rank among great scientific truths. For this purpose he enters the vast field of legendary lore, and shows by the myths, traditions, fables, allegories, and obscure imaginative inventions of all peoples and nations, that something prodigious once happened to this globe, which he claims was nothing else than the deposit of the drift formation which the geologists are so much troubled about. The Greek, Roman, Egyptian, Indian, Arabian, and Aztec theogonies are learnedly ransacked for the evidence they afford to the truth of the new theory. Thirty-nine pages are given to sifting the testimony of Job, who seems to have had a very luminous forecast of Mr. Donnelly's great discovery, and wrote as if he were happy in the idea that he might be permitted to contribute something to it. Then we have twenty-four pages of instructive exegesis, entitled "Genesis read by the Light of the Comet," and at the close of this chapter the author invites attention to the full accordance of the Biblical, Druidical, Hindoo, and Scandinavian legends in confirming "the great unwritten theory that underlies all our religion." The fundamental ideas which underlie the underlying theory of our religion are thus enumerated: "1. The golden age; the paradise. 2. The universal moral degeneracy of mankind; the age of crime and violence. 3. God's vengeance. 4. The serpent; the fire from heaven. 5. The cave-life and the darkness. 6. The cold; the struggle to live. 7. The 'fall of man,' from virtue to vice; from plenty to poverty; from civilization to barbarism; from the tertiary to the drift; from Eden to the gravel. 8. Reconstruction and regeneration."

All the religions of the world being thus levied upon for proofs of the author's theory, and our own being found so eminently tributary to it, we are entitled to say that this is not only a peculiarly scientific book, but also a peculiarly religious book. He certainly makes a good deal of "matter," but he lets us know that he is no "materialist." Be assured, says he, "be assured of one thing—this world tends now to a deification of matter." But we can not heartily commend that combination of waggishness and piety which is but too obvious in a passage like this from his farewell chapter:

> Do not count too much, Dives, on your lands and houses and parchments; your guns and cannon and laws; your insurance companies and your governments. There may be even now one coming from beyond Arcturus or Aldebaran, or Coma Berenices, with glowing countenance and horrid hair and millions of tons of *débris*, to overwhelm you and your possessions, and your corporations and all the ant-like devices of man, in one common ruin.

Again:

> Build a little broader, Dives. Establish spiritual relations. Matter is not everything. You do not deal in certainties. You are but a vitalized speck, filled with a fraction of God's delegated intelligence, crawling over an egg-shell filled with fire, whirling madly through infinite space, a target for the bombs of the universe.

It is to be hoped that Dives will heed these appalling admonitions.

On the whole, "Ragnarok" is too absurd to do much mischief, and contains much that is readable, and that may in a certain way prove instructive; that is, it may serve to kindle an interest in some minds upon subjects to which they would not be attracted by ordinary didactic treatises.

Zoölogical Sketches. A Contribution to the Out-door Study of Natural History. By Felix L. Oswald, author of "Summerland Sketches of Mexico and Central America." Philadelphia: J. B. Lippincott & Co. Pp. 266, with 36 Illustrations. Price, $2.

It is unnecessary to commend to the readers of "The Popular Science Monthly" the writings of Dr. Oswald, but we must keep them informed of what he is doing. His last volume of "Zoölogical Sketches" is undoubtedly the most entertaining of his publications. We know of no delineator of animal traits who has so entered into the spirit of that lowlier order of beings that have hitherto been so contemned, misunderstood, and outraged. For perhaps in nothing has the brutality of man been so exemplified as in his treatment of what he calls the "brutes." No doubt, a kinder feeling is beginning to grow up as his kinship with those below him is better understood; and as men are beginning through the rise of an intelligent sympathy to oppress and abuse each other less, their humble and more defenseless relatives are certain to share some of the results of this human amelioration. Such works as this of Dr. Oswald will do much to strengthen these kindlier sentiments toward the animal creation. There is an exquisite good humor, a lively wit, and a joyous exuberance of feeling in Dr. Oswald's descriptions of the life of our inferior relatives in which nature has not yet been perverted.

The learning of this author in the field of natural history is extensive. We refer not so much to the scientific knowledge of the animal kingdom, its relationships and classifications, as to the knowledge of the ways, habits, instincts, and curious performances of the higher grades of the animate tribes. And this knowledge is by no means of the second-hand order so characteristic of popular books on natural history. Dr. Oswald has been an indefatigable observer of animal habits, of widely extended opportunity in various countries, and with a passion for what we may call companionship with inferior creatures. There is more of novelty, freshness, and out-of-the-way incident connected with the author's experience in this volume than in any other we have lately seen. The admirable woodcuts, no doubt, give effect to many of the curious situations, but the writer's text is pictorial, and vividly images what the limner can not represent. We have undertaken to make some selections, but choice is difficult where you can find nothing better than all the rest. The chapters on "Our Four-handed Relatives," "Sacred Baboons," "Animal Renegades," "Pets," "Secretiveness," "Traps," and "Four-footed Prize-fighters," are especially rich, but the others are hardly less interesting. The book is to be commended not only for its instructiveness as a higher study of natural history, but for its humanizing spirit, its sympathetic insight into animal characteristics, and its vivid and pleasing style.

There is a very considerable unity in Dr. Oswald's various writings. They are animated by a common feeling, and pervaded by the same fundamental ideas. Dr. Oswald is a passionate lover of nature. In his interesting book upon Mexico, the brightness and fervor of his pictures of natural scenery betray the poetical tendencies of his mind, which rejoices in communion with all that is beautiful, picturesque, wild, and sublime in mountains, plateaus, and valleys that have not yet been desecrated and desolated by the hand of man. He holds that "the children of Nature have not lost their earthly paradise"; it is only those that have turned away from her that have fallen. In his book on "Physical Education," there is an earnest pleading for a return to Nature on the part of those who have wandered away into misleading courses under the guidance of false ideas. There is something of sadness in the impatient denunciation and stinging invective of Dr. Oswald's writing, when he speaks of the anti-natural apostasy which has entailed so many evils on mankind. Even in the preface to the present volume, he returns to this subject as giving a clew to the spirit in which it has been written, and the presentation is so characteristic that our readers will thank us for giving the extract entire:

The tendencies of our realistic civilization make it evident that the study of natural science is destined to supersede the mystic scholasticism of the middle ages, and I believe that the standards of entertaining literature will undergo a corresponding change. The Spirit of Naturalism has awakened from its long slumber.

A year after the birth of the Emperor Tiberius, says Plutarch, a Grecian trading-vessel sailed along the coast of Ætolia in the Gulf of Patras, and when the sun went down the crew assembled at the helm to while away the night with songs and stories. The night was calm, and some of the sailors had already fallen asleep, when they heard from the coast a loud voice calling the name of their steersman, Thamus. They were all struck dumb with amazement, but at the third call, Thamus manned himself, and answered with a loud mariner's shout.

"O Thamus," the voice called again, "when you reach the heights of Palodes announce that the great Pan is dead!"

Four hours later, when the moonlit hills of Palodes hove in sight, Thamus complied with the strange request, and, a minute after, the coast resounded with indescribable shrieks and lamentations that continued for a long time, till they finally died away in the heights of the Acarnanian Mountains.

The tradition bears the mark of that suggestiveness which distinguishes a philosophical allegory from a priest legend. Pan was the God of Nature. Can Plutarch have divined the significance of the impending change? Whatever is natural is wrong, was the keystone dogma of the mediæval school-men. The naturalism of antiquity was crushed by supernatural and anti-natural dogmas. The worship of joy yielded to a worship of sorrow, the study of living nature to the study of dead languages and barren sophisms. Literature became a farrago of ghost-stories, monks' legends, witchcraft and miracle traditions, and astrological vagaries. The poison of anti-naturalism tainted every science and every art, and perverted the very instincts of the human mind. Painters vied in the representation of revolting tortures. The exiles of Mount Parnassus assembled on Mount Golgotha. The moralists that had suppressed the Olympic festivals compensated the public with *autos-da-*

fé. The whole history of the middle ages is, indeed, the history of a long war against Nature.

But Nature has at last prevailed. Delusions are clouds, and the storm of the Thirty Years' War has cleared our sky. The real secret of the astounding success of modern science and industry is a general *renaissance* of naturalism, and the same revival begins to manifest its influence in the tendencies of modern literature. Ghost-stories are going out of fashion. Like scrofula and other bequests of the middle ages, the sickly pessimism of the sentimental school is yielding to the influence of a revived taste for the pleasures of out-door life. Books of travel, of sports and adventure, historical, zoological, and even biological and cosmological studies, are fast superseding the historical romances of the last generation. Even the pariahs of our reading-rooms have advanced from ghost-hunts to scalp hunts, from impossibilities to improbabilities. And, moreover, the progress of natural science tends to supersede fiction by making it superfluous—even for romantic purposes. There is more romance in the travels of Humboldt, more magic in the idyls of Thoreau and the revelations of Darwin and Haeckel, than in all the fancies of the mediæval miracle-mongers. The wonders of nature begin to eclipse the wonders of supernaturalism. A Zoölogical Garden attracts more sight-seers than the best Passion-play. Pan has revived.

The plan of the present volume is modest enough: its theories are mere suggestions; its limits have often obliged me to reduce a chapter of zoölogical adventures to a page of zoölogical anecdotes. But, in offering it as a contribution to the entertaining literature of the English language, my diffidence arises from a distrust in my own abilities rather than from the deficient interest of the subject itself, for the history of that literature has repeatedly proved that natural science can be made more attractive than the products of fiction or mysticism—by just as much as the resources of Nature exceed the resources of her rivals.

The Coues Check List of North American Birds. Second edition, revised to date. With a Dictionary of the Etymology, Orthography, and Orthoëpy of the Scientific Names. Boston: Estes & Lauriat. Pp. 165.

The first edition of the "Check List" was published in 1874, and was a bare catalogue of the scientific and vernacular names. It contained seven hundred and seventy-eight names of species and sub-species, and was prepared with a degree of accuracy that is exhibited by the fact that it has been found necessary in the revision to remove only ten names of duplicates or extra-limital species, while a hundred and twenty names have been added. The large majority of the additions are *bona fide* species, and actual acquisitions to the North American list—birds discovered since 1873 in Texas, Arizona, and Alaska, together with several long known to inhabit Greenland. Except in Mr. Ridgway's National Museum catalogue, which was published after Mr. Coues's list was written, the full list of Greenland birds has never before been incorporated with the North American list. The field of North American fauna is generally bounded by the northern boundary of Mexico. The objection is made that this is a political rather than a scientific limit; and Mr. Coues suggests that it would be more exact to extend the limit, along the highlands at least, to about the Tropic of Cancer. In revising the list, particular attention has been paid to the matter of nomenclature, not only as a part of scientific classification, but also as an affair of writing and speaking the names of birds correctly; and the work includes, besides the list of the names, a full and scholarly treatise on the etymology, orthography, and orthoëpy of all the scientific and many of the vernacular words employed in the nomenclature, the work in great part of Mrs. S. Olivia Weston-Aiken.

New Check-List of North American Moths. By August R. Grote, President of the New York Entomological Club. Pp. 75. Price, $1.

This list contains about four thousand names of species, synonyms, and varieties of the North American Sphingidæ, Bombycidæ, Ægeriadæ, Thyridæ, Noctuidæ, Geometridæ, Pyralidæ and Tortricidæ. It will be welcome and useful to the student and collector of the interesting insects which it enumerates. The list embraces all recent discoveries and replaces the former catalogues of the author, as it takes in all the species. It also contains some of the results of a partial re-examination of the British Museum collections made by Mr. Grote last winter, and it includes the Tortricidæ published by Lord Walsingham, and Professor Fernald's recent arrangement of that family. It is well printed, on good paper, uniform in style, with "Papilio," the journal of the New York Entomological Club, and it may be had of the secretary of the club, Mr. Henry Edwards, No. 185 East One Hundred and Sixteenth Street.

House-Drainage and Sanitary Plumbing. Providence: E. L. Freeman & Co.—Anlagen von Hausentwasserungen nach Studien Americanischer Verhältnisse. (Plans for House-Drainage, after Studies of American Arrangements.) Berlin.—Diagram for Sewer Calculations. All by William Paul Gerhard, Civil and Sanitary Engineer. Newport, Rhode Island. Pp. 105, 38, and 7. With Plates.

The first of these publications is a reprint of a paper which was contributed to the fourth annual report of the State Board of Health of Rhode Island, and is an excellent practical treatise on the subject considered. It asserts the possibility of securing an efficient and healthful drainage of houses, whether upon open ground or into a sewer or cess-pool, by methods which are without mystery or secrecy, and involve "nothing more than the proper application of well-known laws of nature"; and explains specifically and with intelligible illustrations the best systems of drains, pipes, traps, basins, bath-tubs, water-closets, and sinks, at the same time pointing out the errors and defects of many of the systems in use. The second work is intended to give to German engineers a description of house-drainage as it is practiced in England and the United States. The third pamphlet is a description of a diagram on sewer calculations constructed by the author, and is of technical value. The first of these publications, revised by the author, is now published by D. Van Nostrand as No. 63 of his "Science Series." Pp. 205. Price, 50 cents.

New Method of Learning the French Language. By F. Berger. New York: D. Appleton & Co. Pp. 138. Price, $1.

The author a few years ago published a "Method" for French pupils learning English, which has been used in France satisfactorily, and with a success that is represented by the exhaustion of fourteen editions of it and a fourfold increase of the number of French students of English in five years. He now applies the features that characterize that system to the study of the French language by English pupils. The features are a simple and careful indication of the pronunciation, and a conversational method, in which are given—1. The French text, with the pronunciation and a literal translation; 2. A review of words; and, 3. The French text again, with the English opposite, translated closely, so as to enable the pupil to translate alternately into French and into English. Besides the lessons on this plan are given conversational phrases, paradigms of the verbs *être* and *avoir*, conversational phrases, a version of Miss Edgeworth's play of "Old Poz," and a collection of words, sentences, phrases, and idioms.

Chapters on Evolution. By Andrew Wilson, Ph. D., F. R. S. E., etc. With 259 Illustrations. New York: G. P. Putnam's Sons. Pp. 383. Price, $2.50.

We have no hesitation in cordially recognizing this volume as a timely contribution to a subject that is now attracting wide and serious attention. It meets an undoubted want, and is certain to prove helpful to all general students of the subject of organic development.

Yet, the title of the book may be objected to as somewhat misleading. It is not devoted to evolution in the full meaning now given to that term, but is restricted to one division of it, which ought to have been designated in the title. It is more properly confined to that phase or section of evolution which has come to be represented by the term "Darwinism," and is a book that should be ranked with Professor Gray's "Darwiniana" and Oscar Schmidt's German volume on "Descent and Darwinism." There should be no confusion here, for Darwinism is not evolution, and is but a part of it. Dr. Wilson virtually concedes this by employing in his text the term "Darwinian evolution," thus recognizing that it is but one sort of something of a larger kind; and also when he speaks of "development" as a strong pillar of the theory of evolution.

With the reservation here made, Dr. Wilson's work, as we have said, may be heartily commended. It is a very full and popular treatise on the important and interesting questions of organic development, and abounds in the biological information that has now been accumulated in illustration of the law of descent with variation. The principle of natural selection is, of course, assumed and interpreted as a great contribution to organic progress, and the various questions that have arisen in connection with the development of the organic kingdom are considered with fullness, and by a naturalist competent to deal with them. In his preface the author observes: "A considerable experience as a biological teacher has long since convinced me that the hesitancy with which evolution is accepted and the doubt with which even cultured persons are occasionally apt to view this conception of nature arise chiefly from lack of knowledge concerning the overwhelming evidences of its existence which natural history presents. Doubtless, a training in botany and zoölogy is required before the case for evolution can be fully mastered, but there need be no difficulty in the way of any intelligent person forming a just estimate of evolution upon even an elementary acquaintance with the facts of biology. I have accordingly sought to bring such facts prominently before the notice of my readers, and I would fain hope that even the complex topic of 'development' itself, a strong pillar of the theory of evolution, is susceptible of easy appreciation when the facts and inferences to be drawn therefrom are plainly stated."

Youth: Its Care and Culture. An Outline of Principles for Parents and Guardians. By J. Mortimer-Granville. New York: M. L. Holbrook & Co. Pp. 167.

The author is known as a thoughtful and vigorous writer on subjects of practical hygiene and discipline. The aim of his present work is to expose "certain fallacies" which prevail on the subject of child management and education, and to indicate, "in suggestive outline," the principles which should guide parents in the care and culture of youth. He considers the physical and moral training of boys and girls, advocating the allowance of the freest scope for physical growth in both sexes, with a "hardy" treatment and no coddling, and a particularity in moral culture which is as strange to the general society of the day as it is much needed.

Dress and Care of the Feet. By Dr. P. Kahler. New York: G. P. Putnam's Sons. Pp. 37.

Dr. Kahler believes that chiropody should be recognized as a profession, and that those who intend to practice it should be scientifically qualified for their vocation. He enforces the importance of caring for the feet, a healthy condition of which is considered very closely connected with happiness and the soundness of the whole body, and particularly of the brain and nervous system. His manual consists chiefly of practical suggestions respecting the treatment of diseases and aches of the feet, concerning the care of the feet that will prevent their acquiring diseases and aches, and on the proper construction and form of shoes.

Report of T. B. Ferguson, a Commissioner of Fisheries of Maryland. Hagerstown, Maryland. Pp. 152, with Plates.

The report describes the work done in the western part of the State during 1880. This work, which includes also the distribution of 1,500,000 shad and 690 carp in waters wholly within the eastern section of the State, under the direction of the Western Commissioner, is regarded as very important, both on account of the success attained in the attempted propagation of several varieties of valuable fish by artificial means, and because of the accumulated proofs which the year afforded of the happy results of the effort fully to restock the waters of the State with shad. A valuable account of experiments and observations in oyster-culture, by John A. Ryder, is added.

Sixth Annual Report of the State Board of Health of Wisconsin. 1881. Madison, Wisconsin. (J. T. Reeve, Appleton, Secretary.) Pp. 146.

The health of the State was generally good during the year, notwithstanding the unusually large number of deaths from diseases of the respiratory organs among old people, caused by the severe winter of 1880–'81. The history of the various contagious diseases which appeared is reviewed. Especial attention is given to the condition of the schools and school-houses, in respect to which the board trust that the beginning of a change for the better may be seen, the end of which shall be that the improvements which are demanded shall receive the consideration due to them, and "the child shall be recognized as a being of higher value than the grade, rather than as subordinate thereto."

First Annual Report of the Board of Health of Detroit. 1882. Detroit, Michigan: O. W. Wight, Health-Officer.

The report appears in the form of a "frank, earnest discourse to citizens on subjects of sanitary importance at home," rather than of a scientific discussion of hygienic concerns. Among the subjects considered are the board's system of dealing with contagious and infectious diseases; the preventive management of small-pox; the sewerage and house-drainage system of Detroit; the question of slaughtering in the city; the administrative method in the case of the abatement of nuisances; the purity of the ice-supply; the milk-supply; the "smoke nuisance"; and the water-supply. Other equally important subjects are reserved for future reports.

Van Nostrand's Science Series, Nos. 59, 60, and 61. Railroad Economics, by S. W. Robinson, C. E.; Strength of Wrought-Iron Bridges, same author; Potable Water and the Relative Efficiency of Different Methods of detecting Impurities, by Charles Watson Folkard. New York: D. Van Nostrand. Pp. 131, 175, 138. Price, 50 cents each.

Mr. Robinson's "Railroad Economics" is the fruit of an official tour of inspection under the direction of the State Commissioner of Railways, over the railroads of Ohio, and is intended to bring out such facts observed, and call attention to such features of practice, as shall assist in the attainment by railroads of a uniform standard of excellence. The second work, which has also been prepared in connection with the State railway inspection service of Ohio, furnishes practical formulas for beams, struts, columns, and semi-columns, as calculated by the author in the performance of his work of examining bridges for strength and trustworthiness. The formulas are not otherwise generally accessible in published form. Mr Folkard's "Potable Water" is the substance of an essay originally presented to the British Institution of Civil Engineers, and considers the various ways in which water becomes contaminated; the methods employed to detect and determine the extent of contamination, and their value; the bearing of the results of biological and microscopical research on the question, and the adequacy or inadequacy of proposed remedial measures.

Ottawa Field Naturalists' Club. Transactions No. 3. Ottawa, Canada. (W. Hague Harrington, Secretary-Treasurer.) Pp. 66, with Two Plates.

The record is for the year ending March 21, 1882. The club has one hundred and fifteen members. Four excursions were held during the summer; a *conversazione* was given on the 6th of January, and a lecture on the "Capabilities of the Prairie Lands of the Northwest, as shown by their Flora and Fauna," was delivered by Professor Macoun, on the 7th of April. Reports of the geological, botanical, entomological, ornithological and oölogical, and conchological branches are included among the Transactions, with papers on the "Geology of the Ottawa Palæozoic Basin," "Pine Life," "The Utica Slate," and other subjects.

Report of the Board of Commissioners of the Ninth Cincinnati Industrial Exposition, 1881. (J. R. Murdoch, Secretary, Cincinnati.)

The Ninth Exposition is believed to have far exceeded in completeness and novelty all that preceded it. The departments of Art, Horticulture, and Natural History, were full of interest and attractiveness, and the expert tests of machinery, a new feature, added greatly to the attractions of that department.

The American Citizen's Manual. Part I. Edited by Worthington C. Ford. New York: G. P. Putnam's Sons. Pp. 146. Price, $1.

This is the fifth of Messrs. Putnam's series of hand-books on "Questions of the Day." It gives plain statements for the information and guidance of citizens, on the nature, distribution, and functions of our governments, national, State, and local, the electoral system, and the regulations surrounding the exercise of the franchise and the verification of the results, and the character of our civil-service administration. The present condition of civil-service abuse and the need of reform are clearly shown under the last head. A succeeding volume will more fully consider the functions of government.

Practical Life and the Study of Man. By J. Wilson, Ph. D. Newark, New York: J. Wilson and Son, Publishers. Pp. 390. Price, $1.50.

A volume of sober essays on topics relating to one or the other of the subjects mentioned in the title, expressed in plain language and pleasant style. The author's object is simply to interest and instruct those who are seeking improvement, by bringing to notice, on the subjects considered, the best thoughts in the language, in his own words, when they have seemed fitting, in the words of others, where they expressed them best. The work has been done not to make a book, but because the author, as he remarks, "feels that he knows much that ought to be written," and with assurance, "because he has studied what he says, and has confidence in his statements."

Schelling's Transcendental Idealism. A Critical Exposition. By Professor John Watson, LL. D., of Queen's University, Kingston, Canada. Chicago: S. C. Griggs & Co. Pp. 250. Price, $1.25.

This is the second of the series of "German Philosophical Classics," which Messrs. Griggs & Co. are publishing, under the general editorial supervision of Professor George S. Morris, of the University of Michigan. In the present volume the editor has endeavored to exhibit the phases of Schelling's philosophical development as they are registered in the various treatises which form their vehicle, supplying all the elements for an independent judgment, together with some hints of weak points of the system.

Speech and its Defects, considered Pathologically, Historically, and Remedially. By Samuel O. L. Potter, M. A., M. D. Philadelphia: P. Blakiston & Co. Pp. 117. Price, $1.

The first prize was accorded to this work as a thesis by the unanimous vote of the faculty, at the fifty-seventh annual commencement of the Jefferson Medical College, Philadelphia. The author selected the subject for his prize thesis, because it was one on which from his own sufferings and experiments he felt "somewhat qualified to write," and could contribute to knowledge; for he had made, in his own person, practical trial of several of the recognized methods of cure, and had examined all the attainable literature on the subject. We give a note of warning from the author to those who have cases of stammering to deal with: "The ignorance of this subject which prevails among those having the care of children, is productive of much distress and serious results to the innocent sufferers. The child who manifests a disposition to stutter is usually abused in more ways than one. The affection is intensified by any cause which disturbs the equipoise of the nervous system; and the most frequent and potent cases of this kind are derived from the reception which his infirmity receives from those who are endowed with perfect speech themselves. Mockery on the part of companions, and threats, even blows from parents and teachers, have made more confirmed stutterers than any other extensive influence, besides making the life of the patient one of unutterable wretchedness."

The Magazine of Art. London, Paris, and New York: Cassell, Petter, Galpin & Co. December, 1882. Monthly. $3.50 a year.

We have received Messrs. Cassell, Petter, Galpin & Co.'s "Magazine of Art," as it has appeared in monthly numbers through the year, with much satisfaction, and are pleased to commend it as a good representative of what is true and meritorious in art. In its letterpress it teaches what it is well to teach in art, in a manner that appeals to the popular understanding and is likely to elicit popular interest. Its illustrations are selected with discrimination from worthy and agreeable subjects, and are well executed, while the typography is nearly perfect. Its articles are varied in subject and method, and its news and other departments are acceptably sustained; and a fair degree of attention is given to American art. In the December number some of the American pictures at the *Salon* of 1882 are candidly criticised; articles are given on Japanese book illustration; a subject of prehistoric art; a department of ceramics; the works of an Italian artist; and Mr. Hamerton's "Graphic Arts," all of which are appropriately illustrated.

The "Revue Scientifique," of Paris, has won a high rank among journals of its class, by the prominent space it gives to the original papers of leaders of scientific thought, and by the international catholicity which it has shown in enrolling among its contributors writers from different countries in Europe and America, including such men as Pasteur, Berthelot, Wurtz, Milne-Edwards, Tyndall, Huxley, Du Bois-Reymond, Virchow, and some of our own men of science. It is edited by Charles Richet, a physiologist eminent particularly in the investigation of nervous disorders. It is published by Germer-Baillière & Co., 108 Boulevard Saint-Germain.

The next number of the "International Scientific Series" will be on a subject of unusual popular interest, and of extreme importance. It will be on "The Science of Politics," and is contributed to the series by Dr. Sheldon Amos, author of "The Science of Law." The science of politics is a subdivision or branch of social science, the next great subject in the order of scientific progress. The science of politics is therefore in the early stage of its development, and, as its principles are as yet but imperfectly elucidated, no treatise upon it can have completeness, or the authority of perfected elucidation. Nevertheless, the beginning must be made, and already enough is known, both of the data of the inquiry and the method to be employed, to give great interest and value to a well-elaborated popular treatise.

PUBLICATIONS RECEIVED.

Annals of the Astronomical Observatory of Harvard College. Vol. XIII, Part I. Micrometric Measurements. By Joseph Winlock and Edward C. Pickering. Cambridge, Massachusetts: John Wilson & Son. Pp. 203.

Transactions of the Linnæan Society of New York. Vol. I. New York: L. S. Foster. Pp. 168.

"The Decorator and Furnisher," December, 1882. 75 Fulton Street, New York: E. W. Bullinger. Pp. 32. Price, 35 cents.

The Manufacture of Iron and Steel direct from the Ore. "Bull's Process." By Mr. Vaughan W. Jones. Liverpool, England: Andrew Russell. Pp. 15.

Spirits in Prison. A Discourse delivered on a Special Occasion. By George E. Ellis. Cambridge, Massachusetts: John Wilson & Son. Pp. 27.

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POPULAR MISCELLANY.

Observations of the Recent Transit of Venus.—Professor C. A. Young has published in the "New York Times" a summary of the results, so far as they can be estimated so soon, that have attended the observations of the transit of Venus of December 6th in this and other countries. On the whole, he says, the observations were successful beyond expectation. Although in the United States there was more or less cloudiness, there were very few stations that did not succeed in accomplishing the most essential portions of their intended work. The first contact, although it is the most difficult part of the phenomenon of which to get an accurate observation, and although it was not seen by more than half as many observers as the other three contacts, was noted by some of the observers at twenty out of the thirty-nine stations on the continent where it might have been visible. An unusually satisfactory observation was obtained at Princeton. The other contacts were observed with more general success, the second at twenty-nine, the third at thirty-two, and the fourth at thirty stations. As far as can be judged from the present incomplete calculations, "it would appear that the planet was about 20″ to 25″ behind time in her orbit, and that her diameter assumed in the computations was at least 1″, and probably 1·5″, too large. The duration of the transit appears, also, to have been about 25″ longer than computed, which might indicate either of two things or a little of both—that the planet was 1″ or 2″ of an arc north of its computed position, or that the diameter of the sun is a trifle larger than was assumed. The agreement, however, was remarkably close." Heliometer observations were made by German parties at Hartford, Connecticut, and Aiken, South Carolina, and by Professor Waldo, at Yale College. Measurements of the sun's diameter by similar or somewhat different instruments were also made by the French at St. Augustine, the Belgians at San Antonio, and—with a wonderfully simple but accurate apparatus—at Cambridge and New Haven. Photographs were taken by different methods at a number of places, and with unexpected success, except at Washington. "At Fort Selden and at the Lick Observatory the day was perfect, and the photography went on without a hitch." Micrometric observations for the diameter of Venus were made at fifteen or sixteen stations on this continent, and perhaps at nearly as many more foreign stations. The results are not yet reduced, but the indications correspond with the conclusion, which was drawn from the contacts, that the planet's diameter is really considerably smaller than has hitherto been assumed. The photometric observations showed that Venus was distinctly darker than the sky just outside of the sun's limb. The results of the spectroscopic observations at Cambridge, South Hadley, Princeton, and Alleghany were "purely and surprisingly negative," and showed for the most part no conspicuous evidence of selective absorption by the planet's atmosphere. The Princeton observers, however, were so fortunate as to find distinct indications of water-vapor, thus confirming certain old observations of Huggins. Professor Langley, at Alleghany, observed a spot of abnormal brightness in a part of the atmosphere of the planet where such an appearance would be least expected, which may denote auroral and magnetic phenomena. Professor Harrington, at Ann Arbor, made out spots and markings on the planet's disk, but no one else has spoken of them. In Europe the weather was generally bad. Good observations were made, however, at Potsdam, Prussia. The reports so far received from the southern hemisphere are most gratifying; and, whatever it may be with the stations yet to be heard from (chiefly near the Straits of Magellan), "enough is already secure to make it certain that we have observations sufficient in number and character to test the full value of the transit as a means of determining the solar parallax." It must be several years, however, before the observations can be fully reduced and published, and the exact results ascertained.

Work of the Dearborn Observatory.—The great equatorial of the Dearborn Observatory, Chicago, was employed during 1881, under the direction of Professor G. W. Hough, chiefly in the observation of the great comet of the year, the planet Jupiter, the satellites of Uranus, and difficult double stars. A drawing of the nucleus and envelope of the comet, showing the peculiar formation of the head and surrounding envelopes, was made on the 23d of June by Professor Colbert, who also first announced the distance of the comet from the earth. In attempting to reconcile the various phenomena alleged to have been seen on the disk of Jupiter, the greatest difficulty is found to exist in determining what is real and what is imaginary. Contemporaneous sketches by different persons, or even two by the same observer, show such marked discrepancies that they are of but little use in ascertaining suspected changes. The observations made here during the past three years confirm the statement that the changes on the disk of the planet are slow and gradual. The attempted observations on the inner satellites of Uranus were impeded by unfavorable night weather. About two hundred and fifty micrometer measurements of double stars were made, including nine measurements of the companions of Sirius. Sixty difficult double stars, not found in the catalogues, were discovered, including two quadruple systems and one naked-eye star, with a very minute companion. Mr. S. W. Burnham is preparing for publication a catalogue of one hundred and fifty-one double stars discovered at the observatory during the past three years; also, a compilation of all the star observations made by him during the same period, comprising about twenty-five hundred measurements. The observatory is open to members of the Chicago Astronomical Society on Thursday evenings; and classes from the city high-schools and elsewhere are occasionally admitted.

The Poles of Extreme Cold.—There appear to be two districts on the northern hemisphere, widely separated from each other, in which the coldest places on the earth are to be found. One is in Northeastern Siberia, the other in the American Arctic Archipelago. The particular points within these regions, that have the property of being colder than all surrounding points, may be called the poles of extreme cold. Their geographical situation is not precisely ascertained, because a sufficient number of observations have not been made, but enough is known to make it safe to conclude that the Asiatic pole is north of Yakutsk, and the American pole northwest of the Parry Islands, toward Eastern Siberia. The Asiatic pole is upon the mainland, the American pole in a sea studded with islands; and from this the two regions derive distinct climatic characters. Near the Siberian pole, which lies in the comparatively low latitude of from 60° to 70°, the continental climate is exhibited in an extremely cold winter and a warm summer, while the more maritime climate of the American pole, which lies between 65° and 68° of latitude, is expressed in a relatively milder winter and cooler summer. Yakutsk has hitherto been considered the coldest place on the earth, it having a mean temperature in January of −45°. Colder places have since been found that have a mean temperature for January as low as −55°. They are situated in about latitude 67½° north, near Werkojansk, in Siberia. The cold-pole is located here from November till March; it then moves in April and May toward the northwest into the Arctic Ocean, between the mouth of the Obi and Nova Zembla, and afterward returns to Werkojansk. Werkojansk is the only place that lies within the isotherm of −40° during November, December, January, and February, or for four months; Yakutsk suffers this mean temperature during December and January; Ustjansk, at the mouth of the Yana, only during January; while Tolstoi Noos, at the mouth of the Yenisei, lies entirely outside of the isotherm of $-40°$. The mean annual temperature of the Siberian cold-pole may be estimated at $2°$. A still colder place appears to have been found by M. Klutschak, of Lieutenant Schwatka's expedition, at the Adelaide Peninsula, in Cockburn Bay, latitude 66° to 68°, where the temperature in January, 1880, reached $-72°$; in December, 1879, and February, 1880, $-68°$; and in September, October, and November, 1879, $5°$, $-38°$, and $-49°$ respectively. The mean temperature from December to February, $-48°$, varies but little from that of Werkojansk, and is from 18° to 21° lower than had been previously noticed in the American cold region.—*Die Natur.*

Do House-Flies convey Infection?—Dr. Thomas Taylor, of Washington, has published an account of some examinations he has made into the capacity of the common house-fly to transmit disease by carrying the germs from place to place. The question is really one of exceeding importance, for, "considering the habits and habitat of the house-fly, it will appear evident that, should it prove to be a carrier of poisonous bodies, its power to distribute them in human habitations is greater than that of any other known insect. Under our system of public travel, the common house-fly may be transported from one end of the continent to the other. It may feast to-day in the markets of Washington, and to-morrow in those of New York, and in a like manner it may be transported from a hospital for contagious or infectious diseases to homes in the vicinity, or even in remote localities. It may also be taken from one hospital to another, or from one ward to another within the same hospital, and may plant the germs of disease in exposed wounds, or deposit them in food, or liberate them in the atmosphere breathed by patients afflicted by diseases of a different class." Millions of the minute germs of putrefaction could be carried to a distant city by a single fly. These considerations justify and should prompt inquiry. Dr. Taylor's attention was called to the subject by his witnessing the sufferings of a fly afflicted with *anguilulæ.* In the direct experiments which were suggested to him by this observation, the larvæ of flies confined in a receiver with rust-spores ate the germs. When spores were sprinkled on sugar, the insects themselves consumed both spores and sugar; but some of the spores became fastened on the legs of the flies, and were only the more closely attached by the efforts made to get rid of them. They might, however, be brushed off by objects with which they were brought in contact, while their germinating powers would long outlast the life of the insect itself. Dr. Taylor regards it as evident from his experiments that flies are capable of conveying spores to plants and other bodies, but considers that the fact that the greater part of the spores were consumed by the flies or their larvæ shows that the insect may destroy microscopic germs as well as disseminate them, and indicates that in some cases its agency in keeping down their number may more than counterbalance its action in contributing to their dissemination.

American Stature.—Mr. George W. Peckham, teacher of biology in the Milwaukee High School, has been making investigations under the auspices of the Wisconsin State Board of Health into the growth of children. From examinations and measurements made chiefly in the schools of Milwaukee he has deduced the conclusion that the relative rate of growth of the sexes is such that the boys are taller till the twelfth year and heavier till the thirteenth, after which, between thirteen and fifteen the girls are both taller and heavier. After the age of fifteen, however, the boys exceed the girls both in weight and stature. Girls cease to grow when about seventeen years of age. Children of pure American descent are taller than children of foreign-born parents, but are generally lighter in weight than children of German parents. The children of Irish parents are also taller than those of German parents. Comparing his results with those of similar observations made in Boston, he concludes that school-children in Milwaukee are taller than those in Boston, and the boys weigh more, but the girls of Boston are slightly heavier than those of Milwaukee. The superiority in height of the Milwaukee children is ascribed to the inferior density of population and the existence of fewer urban disadvantages in that city than in Boston; and the general hypothesis is drawn, from Mr. Peckham's tables, that the height of American-born men is more modified by the conditions accompanying density than by all other influences, race excepted, urban life as compared with rural life tending toward a decrease of stature. The rate of growth of Germans appears to be considerably modified by residence in this country through one generation; and, in intermarriage between Americans and Germans, the offspring seem to take the height of the taller parent.

Use of the Gummy Secretions of Plants.—Inquiry has often been made respecting the functions of the secretory apparatus of plants, or that which stores up special juices, such as the resins, gums, caoutchouc, milky juices, and the waxes. Sachs, even in the last edition of his botany, places these substances among those the office of which in the economy of the plant is wholly unknown. Because the secretions in question have been observed to be poor in oxygen and generally unassimilable, they have commonly been regarded as waste matter, useless to the organism. M. de Vries is of a different opinion, and regards these substances as a kind of protective salve, and considers them helpful in the healing of wounds. Of the resin of conifers, he remarks that, if it were simply a product of secretion, the accumulation of it would not cause the tree to suffer. The extraction of resin, however, weakens pines very considerably, and diminishes the growth of wood by about one third. Accidental wounds, moreover, and even normal wounds produced by the fall of limbs or by splitting of the bark, are very numerous in conifers. Whenever a wound is produced, it is forthwith covered over with a viscous and thick mass of resin, which gradually hardens in the air. Among non-resinous plants wounds become isolated by means of a pad of healing tissue which sometimes covers the wound completely over, but often too late to effect the purpose. From this point of view, M. de Vries suggests, the conifers are superior in organization to common angiospermous trees. The organism in coniferous trees seems in a manner to have foreseen possible wounds, and a system of canals designed solely to furnish a covering for wounds seems to have been differentiated in them. In a second part of his work, M. de Vries treats of the function of the juices analogous to the resins which are found in other plants, and seeks to assimilate to the resins, from different points of view, the latex, some of the gums, caoutchouc, and waxy matters. He shows that these substances also exude for the occlusion of wounds, even in herbaceous plants like the northern chicories and spurges, and cites some recent experiments by M. Moll in favor of his view. It would, however, be a narrow judgment to conclude with him, from these experiments, that the sole object of the secretions is the healing of wounds. M. Raumhoff, criticising the work of M. de Vries, has shown that the considerations on which his theory rests do not furnish an adequate demonstration of it. It is evident, for instance, that the purpose of the lactiferous tissues can not be solely the healing of wounds, for these tissues in the spurges contain starch, a substance that does not assist in that office, and which is not a product of secretion. The studies of M. Treub on the tropical spurges furnish evidence that one of the probable offices of their lactiferous tissues is the conveyance of starch.

The Possible Annual Yield of a Forest.—The basis on which all sound forest management depends, says Colonel G. F. Pearson, is the revenue which any forest can be made to pay—that is to say, the income which it will produce in proportion to the volume of the standing trees, or, in other words, its capitalized value. To this end a forest should be considered as so much capital, represented by so many cubic feet of wood; while the amount of wood produced each year, by its growth, represents the interest thereon, and, in fact, is the revenue of the forest. It is evident that it is possible to cut and remove every year a quantity of timber equal to this annual increase of wood, without diminishing the volume of the standard crop. The possible annual yield of a forest may be estimated on the basis of a calculation that a tree, ten feet in girth, which makes a ring of wood of only one eighth of an inch in thickness, adds to its bulk at the rate of rather more than one cubic foot of timber annually for every ten feet of the length of its stem; or, in other words, such a tree, if its stem be thirty feet in height, will, in thirty years, have increased in bulk by at least one hundred feet of solid timber. At the same time, during these thirty years, the young trees which are springing up will have become perfectly hardy, and capable of supporting the whole force of the summer heat and winter frost.

Marriage Customs of the Kacheen.—Mr. R. Gordon, who has been exploring among the sources of the Irrawaddy River, has given to the Royal Geographical Society some additional facts concerning the marriage customs of the Kacheen, the curious Burmese tribe who were described by Lieutenant Kreitler in the July number of "The Popular Science Monthly": "When a man and woman set up house, the man has to give to the parents of the woman cattle, pigs, gongs, muskets, *das*, slaves, clothes, spears, and money; and for his wife's use he has to give coral beads, *tamcings*, jackets, broadcloths, etc., according to his circumstances. After the gifts the woman is brought to the man's house, and the man has to feast the bringers of the woman with rice, and curry, and spirits, and liquors. To the elders, also, he has to give blue waist-cloths, turbans, *das*, or spears, according to their degree. The man then shows the woman all the work to be done in the house, and bids her do the work. After having lived together for a long period, if the man dies, the woman can not marry any one; but the elder or younger brother has to set up house with her. If there be no brother, the deceased man's father (the woman's father-in-law) takes possession of her, and makes her his wife. If an elder brother dies, the younger brother takes over his wife. If the father dies, the son takes over his father's wives, and makes them his own, except his own mother. If a wife dies, the husband goes to her parents and asks for another wife, and they have to give him her elder or younger sister—a woman who is unmarried. If there be no sister to give, they have to give a female relative. Husbands and wives must not be at enmity with each other. Divorce is unknown as a custom. However bad husband or wife may be, they can not separate, unless, in the case of the husband, he gives double the amount of what he originally gave her, and, in the case of the wife, unless she gives quadruple the amount she originally received. If the man sets aside his wife and takes another, the head wife has the right to take possession of all the property of the younger wife, as well as to sell her. The young unmarried men and women, so long as they are not brothers and sisters, act as they please inside the apartments of the house." The Kacheen women wear waist-cloths dyed black and blue, five hands long and not very wide. The jackets are close-fitting, and over them they have a looser one set off with cowries. This is probably full dress. Round their waists they have perforated cowries on three or four hoops of rattan. From their knees down to their calves they wear hoops of rattan. Some women, the wives of the principal men, tattoo their legs from the knee to the ankle.

European Technical Schools.—Mr. Edward C. Robins has presented to the British Society of Arts the results of the inquiries he has made into the causes of the differences in the degree in which different countries have profited from technical education. The clew is not found in differences in primary education; but, when the provisions made in foreign colleges for higher education are examined, something will be found in them so superior to anything in England as to afford a lesson of value. The intellectual and social condition of the industrial population, he premises, and the character of the education it should receive to fit the national mind to cope with the national progress, can not be met by an extension of scholastic institutions, based on the requirements of the middle ages. Yet this is the principle which has dominated the universities, "and, until very lately, no concessions have been made to the reasonable demands of progressive civilization." Secondary and primary education are left in no better condition with reference to this point. The improvement in the technical education of the masses, however, which has begun in the board schools, and is destined to widen, will necessitate a like improvement in all the grades above them. The English are nevertheless gaining in artistic development, and the freedom of choice and the individuality of the English artist are beginning to tell abroad, and English taste in architecture and ornamental design is rapidly supplanting Continental. It is to England that Germans come for Christmas-cards, original ornamental pottery, patterns for embroidery, etc.; "and, in Vienna lately, I could scarcely buy a souvenir that was not adorned with cuttings from Kate Greenaway's charming crudities." The Royal Commissioners on Technical Education show in their reports that, among the French, it is not in the technical education of the ordinary working-classes that the differences sought are to be found; and the reports of the French commissioners reveal a state similar to that prevailing in England, so far as their ordinary workmen are concerned. Schools of arts and trades have been established, but their pupils expect to be foremen, not workmen. Apprenticeship schools have also been started, with more promising results. The best and most successful technical schools are in Switzerland and Germany, and conform, as a rule, to Professor Ayrtoun's definition, that they are not a school where the manipulation or routine of a trade is taught, but one where a lad receives general instruction in the principles of applied science, and special instruction in the application of those principles to the particular trade he is following, or which he is about to follow. In them everything is taught that can be gained at the universities, except the dead languages, while modern languages and the applications of modern science to art and industry are added, with such thoroughness that nearly all the leading men of England have found it desirable to spend some years in Germany. In the *Polytechnikum* at Zürich, Professor Meyer teaches chemistry in a purely scientific direction, irrespective of any practical application; then Professor Lunge treats the chapters which refer to practical applications, at greater length, and enters into a number of details relating to various chemical industries, placing the technical side foremost, but laying the principal stress on explaining the scientific principles underlying the applications. Models of every kind of mechanical action and of every kind of machine are found, but manual labor is excluded; while the student in architecture, for instance, has to work out the strains of every floor or roof or specialty in construction, and to delineate the same in skeleton diagrams attached to every plan he draws; and the mechanical draughtsman is not given a subject to copy, but only the parts of a machine, which he has himself to piece together, thus thoughtfully working out in practical draughtsmanship the theory he has been taught to apply constructively. The highly educated young men from these *polytechnikums* finally become masters when they can, but are not ashamed, till then, to act as foremen of manufactories, etc.

M. Respighi on the Light of Comets.—M. Respighi, admitting the fact that a part of the light of comets is due to the reflection of solar light, is of the opinion that it is yet too soon to decide that any part of it is a proper light due to the comet's own incandescence. He believes that the discontinuity of the comet's spectrum, and the bright lines or bands, may proceed from light modified by passing through the masses of vapors or gases, of which the cometary bodies are composed. It is certain, he observes, that a large part of the cometary light comes from the interior of the bodies, and passes through extensive strata of vapors, in which it is subjected to a selective absorption that causes it to give lines different from the Fraunhofer lines of the sun. So we may have both the weak but complete spectrum produced by the light reflected from the outer strata in which the absorption has been insensible, and another spectrum coming from the deeper parts, with which the absorption has been greater. This view is confirmed by M. Respighi's spectroscopic observations of comet *b*, 1881. The phenomenon, he observes, is of a similar nature to that of the dark bands of the spectrum of the sun in the horizon, but is greatly exaggerated in the case of the comets by the enormous volume of the vapors, the richness of their chemical composition, and the feebleness of the light they reflect.

Nerve-Vibration as a Remedy.—Dr. J. Mortimer-Granville writes in the "Lancet" that enlarged experience in nerve-vibration, as a means or method of treating disease, has confirmed his belief in its value, and he has no longer any hesitation in recommending its adoption by the profession. He has employed it in a very considerable number of cases, differing widely in their nature and characteristics, and, although he has had many failures—mainly, as he believes, from errors in diagnosis, and mis management in the application of the treatment—"the net result has been such as to place beyond reasonable question the fact that, in precisely applied mechanical vibration of nerves and nerve-centers, we have a means of eliciting function and stimulating nutrition which surpasses for directness and rapidity of action any other system or method extant." Regarding the principles of the practice, Dr. Mortimer-Granville believes that, in the treatment of neuralgia, percussion acts simply by interrupting a morbid series of vibrations and substituting for it another series which is not morbid. Its success is by no means certain; but it deserves a trial, and particularly in cases which would otherwise be treated by nerve-stretching. The method is believed to be of the highest possible value for the rousing of torpid nerve-centers and eliciting function from the several organs of the body. Every organ "may, in the absence of disabling organic disease, be made to perform its proper function by exciting the nerve which supplies it with energy by mechanical vibration. In this way I have seen the liver unloaded, and what seemed to be inveterate torpidity of the intestines remedied in a few successive vibrations. I have now under treatment the case of a child who was six weeks ago to all appearance an idiot, but who has already developed so much cerebral activity and growing intelligence, under the influence of specific center and nerve-vibration, that I entertain the strongest hope of his ultimate awakening, and a fair approach to the normal state. A surprising amount of success has attended percussion in cases of obstinate and what was supposed to be irremediable deafness. . . . In neurosthenia, neurasthenia, and even commencing sclerosis of the spinal cord with loss of tendon reflex, the most remarkable effects are produced by applying the *percuteur* over the spinous processes of the appropriate vertebræ."

Obituary.—Science, in California, lost by the death of the Hon. Benjamin B. Redding, State Fish Commissioner, in August last, one of its most active promoters. Mr. Redding was a Regent of the University of California, and President of the Board of Trustees of the California Academy of Sciences. He took great interest in all scientific work, especially in the paleontology of the Pacific coast, and was an indefatigable collector of prehistoric and aboriginal relics. He was also a member of the Geographical Society of the Pacific, and read before it in April last a paper describing a visit to the Galapagos Islands, made in 1850. A list of his contributions to current literature since October, 1877, contains the titles of more than eighty papers, nearly all of which had a scientific bearing. No record is preserved of his previous contributions. His papers have been described as always full of original facts, clearly and simply expressed. Mr. Redding was fifty-eight years old.

NOTES.

A powerful magnetic storm prevailed, both in the United States and England, shortly after the middle of November, reaching its intensity in both countries on the 17th. It was described by American electricians as unlike any disturbance heretofore known, and as acting upon the wires in strong waves, which produced constant changes in the polarity of the current. In England, Mr. Preece pronounced it the most terrific storm he had ever witnessed, after thirty years of observation, and described it as characterized, like the American storm, by alternate waves of great strength. The storm was accompanied, in both countries, by brilliant auroras on the night of the 17th. French accounts represent the storm as equally remarkable on the Continent.

The death is announced of Dr. Franz Ritter von Kobell, Professor of Mineralogy, and keeper of the mineralogical state collections at Munich, Bavaria. He was seventy-nine years old, and was well known through his numerous mineralogical publications.

M. Melsens, a Belgian physicist, has suggested that objects which it is most important to protect from lightning, like powder-magazines, should, besides being furnished with lightning-rods, be wholly surrounded with a metallic net-work. He rests upon the fact that animals in such inclosures never experience any mischievous effects from discharges which must, under ordinary conditions, have stunned them. A correspondent of the French Academy of Sciences asserts that trees that have been struck by lightning have, for many years afterward, the same effect upon the compass that magnetized bodies have. The statement needs verification.

M. G. Le Bon has called attention to two new and very effective antiseptics, the glyceroborate of calcium and the glyceroborate of sodium. They are both very soluble, odorless, and unpoisonous, and deliquesce rapidly when exposed to the air. They are powerful antiseptic agents, even in very dilute solutions. The calcic salt appears to be the more effective of the two, in a therapeutic point of view, and may be applied, even in strong solution, and to so delicate an organ as the eye, without bad results. These salts have been proved to be excellent preservers of meat during a South American voyage.

It is not Professor Louis Palmieri, as stated in our last number, who is dead, but his nephew, Marino Palmieri, Professor of Physics in the University of Naples, and also well known for his seismological researches. We referred the death to the older Palmieri through an error in the balancing of probabilities. The English journal, "Nature," contained a notice of the death of the younger Palmieri, at the early age of thirty-two years; the French journal, "La Nature," of about the same date, gave the obituary as of Luigi, the septenarian. Considering both publications entitled to an equal degree of respect, we regarded the probabilities as in favor of the death of the elder one, who had passed the age of threescore and ten.

The new volume in the French edition of the "International Scientific Series" is on the "Origin of Cultivated Plants," by M. de Candolle. It appears from this author's researches that, out of about 40,000 known species of plants, mankind make use of only about three hundred.

The Marquis of Nadaillac, author of a famous work on "The First Men," has just completed a work on "Prehistoric America," published by G. Masson, Paris, which, according to "La Nature," is the first complete work on America prior to the Spanish Conquest that has been placed within the reach of the French reading public.

In "The Popular Science Monthly," vol. v, page 198, mention is made of an immense Japanese spider-crab in the cabinet of Rutgers College, New Jersey, which measures eleven feet six inches when extended. It is the *Macrocheira Camperi*. It was for many years the largest specimen known in any collection. Since then one ten feet long was taken to Edinburgh. A specimen is now advertised for sale in London, which measures over fifteen feet in length! The strange thing is, its owner appears to be ignorant of its name.

The international series of stations, for the examination of the polar regions and phenomena, have been completed, and the designated posts have all been occupied by the parties representing the several states to which they were assigned. The United States is represented at Point Barrow and Lady Franklin Bay, by parties under Lieutenant Ray and Lieutenant Greeley; Great Britain and Canada, at Fort Rae; Germany, at Cumberland Gulf and the South Georgian Islands; Russia, in Nova Zembla and at the mouth of the Lena; Austria, at Jan Mayen; France, at Cape Horn; and Denmark, Sweden, Norway, Finland, and the Netherlands, at other points in the Arctic regions.

On the 25th of July, 1881, the British Indian Survey observed an extraordinary outburst of solar spots, covering 630,000,000 square miles. The phenomena were all observed within a period of thirty-seven minutes. Says "Nature," "It is rare that so grand an outburst is so closely located in time."

The citizens of Montreal have begun their preparations to receive the British Association in 1884, by sending out circulars to inform their invited visitors that the city can take care of them, and that they will find their visit a pleasant one. Among the inducements held forth are easy excursions to Quebec and Ottawa, and longer and pleasant ones to Toronto, Niagara Falls, Boston, New York, and New Haven, or whatever Eastern city the American Association may meet in. The Government of the Dominion is expected to make liberal grants of money to defray the expenses of British members, the railroads and steamboats will provide excursions to the Great Lakes and Chicago, and to the provinces of the Northwest as far as the Rocky Mountains; and the Association is promised its usual revenue from the meeting.

The extreme western boundary of the United States is in the Island of Attoo, as far beyond San Francisco as that city is from Maine. San Francisco is thus only the half-way station in the journey across our country.

SIR CHARLES WYVILLE THOMSON.

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THE GROWTH AND EFFECT OF RAILWAY CONSOLIDATION.

By GERRIT L. LANSING.

IT is charged by the politician, it is spread by the press, and it is believed by the people, that railroads, being operated in the interest of the corporations themselves, are operated against the interest of the communities; that by consolidations and combinations all competition is removed, and monopolies are formed which levy extortionate tolls, with no regard to the rights or interests of their patrons. And so dangerous, it is believed, has this arbitrary exercise of power become, that the people of the whole country are invited to bind themselves together into an "anti-monopoly" league, to be able to strike for their liberties, and punish the destroying avarice of these giant corporations.

There is an increasing number of inquiring minds who have come to look with distrust upon the statements of politicians, the opinions of the press, and that popular judgment which is based upon the misinformation furnished by these. It is the purpose of this paper to inquire into these charges and beliefs and endeavor to disclose what truth or error they may contain.

The word *monopoly* is associated in the mind with the legal and artificial monopolies of the last three centuries. Such, for instance, as the Dutch East India Company, which, having the entire product of the Spice Islands, would destroy a portion of the crop rather than lower the price by bringing the whole to market. The workings of all these old monopolies were opposed to the public good, as they were operated in the maintenance of high prices. In England, under the successors of Henry VIII, they had become so numerous and grievous, that by an act of James I, all monopolies were abolished excepting the right of patents.* To this has since been added, in England and America, the government monopoly of the postal service.

Yet, all railroads are monopolies in a certain sense and to a certain extent; that is to say, they are without practical competition between certain points. The use of the word *monopoly*, however, as applied to railroads, should be qualified by the word *natural. Natural monopolies* are such because, under the free and equal operation of the laws of nature and of the nation, they monopolize the business by doing it more satisfactorily, more economically, and more expeditiously, than it can be done by any other means. Insomuch as they fail in this, they are not monopolies. There should not, then, be associated with the idea of natural monopolies the old and well-grounded hatred that existed against legal monopolies. The latter, under the operation of special laws, were operated for the benefit of the few; the former, under the operation of general laws, are operated for the greatest good of the greatest number. There seems no better illustration of the change which has taken place in the meaning of this term in the popular mind than its present application to free competing corporations; and that one, among the prominent measures of reform proposed by the "anti-monopolists," is the absolute destruction of all competition through the operation of the entire railroad system of the country by a great government monopoly.

Combination and consolidation being the spirit of monopoly, are supposed, in the public mind, to be opposed to the common good. But they contain the actual substance of *natural* monopoly, which is such from its merits and benefits, and not from privilege.

Consolidations produce responsibility and uniformity in their service, economy in their operations, and tariffs at minimum rates. These are the essential requirements of the public good, and these the public constantly receive from the great corporations. By the consolidation of several branch lines under a central management, an economy is effected in all those expenses of general supervision, and of junction and terminal stations, which, under the individual operation of the roads, each has to stand by itself. This is, in fact, a reduction of the ratio of expenses to the amount of business done, as it reduces to a minimum those fixed expenses which have little relation to the increase or decrease of traffic; and, as the consolidated company has a much larger traffic over which to distribute these fixed expenses than the short line, it becomes possible for the former to make lower rates and still have the same profit earned by the latter on higher rates.

Again, consolidations are continually being effected between short lines and roads without any through connections. On these the highest rates have always prevailed, because their traffic has been always limited. By a combination with other lines having a common interest, and perhaps by building a short line to connect them, they become

* Blackstone, book iv, p. 159.

part of a through route ; and the addition of the through to the former local traffic reduces still further the ratio of the cost of service.

This reduction in the ratio of the cost to the amount of traffic, which results more or less from all consolidations, secures an increase of profits even with no change in the rates or traffic. Thus far there is an injury to no one, and a benefit to the stockholder. But the advantages of the consolidation do not stop here. It has made possible lower rates with the same profit that formerly was earned with higher rates. Without risk of injury the new company is now able to make greater reductions in the rates on those local products of nature and of man, which will allow them to reach more distant markets, or will stimulate their development by enabling them to sell in their former markets with greater profit. By this means, more than by any other, is the railroad enabled to secure an increase of traffic ; and, as an increase of traffic can be carried with only a fraction of the relative increase of cost, the decrease of rates increases the net income.

The extension of the same policy leads to the highest development, both of the resources of the country and the earning power of the corporation. To effect the increase of traffic is the constant study and aim of the railroad manager ; and it is a self-evident fact that the increase of traffic can only be secured by furthering the interests of the shippers. It is true that all railroads, both great and small, have the same necessary interest in the prosperity and development of the territory served by them, and they all alike endeavor to increase their traffic. But the large corporation, supported by the traffic of the various products of many districts, is in a better condition to experiment in the development of new districts and industries. It frequently affords thus a rate or service beyond the point warranted by the present traffic, and is able to operate portions of its system at a temporary loss, in the hope of a future gain. With a small road, on the other hand, depending upon the present traffic of a limited area, its rates must be immediately remunerative, and to meet the current expenses there is frequently required the practice of every temporary economy, even at the expense of the future value of the property. The small roads, unless the circumstances are exceptional, maintain the highest rates, and afford the poorest service. The interest of the great companies in the development of the districts from which they derive their revenue is in proportion to their size ; while their more economical management and extended resources free them from the bonds that confine the small local corporations.

That the advantages accruing from consolidation lead toward the adoption of that policy throughout the world is a conspicuous feature of railroad development ; and the facts overwhelmingly demonstrate that the results as constantly lead to a reduction of the tariffs.

The Massachusetts Railroad Commissioners, in their report for 1873 (page 80), draw the following conclusions, after an examination of the experience of Great Britain upon this subject, which may fairly be taken as an illustration of the general law: "The evidence," they tell us, "published at great length in the 'blue-books,' seems to be almost conclusive that positive benefit rather than injury has there resulted from amalgamation, so far as it has gone. Not only have the evils anticipated not resulted, but it would seem that the public has invariably been better and more economically served by the consolidated than by the independent companies. The larger companies employ abler officers, and seem to be managed more on the system of great departments of commerce, and less on that of lines of stage-coaches; the time and attention of the officers are not mainly absorbed in questions of corporate hostility, and the money of the companies is wasted in a somewhat less degree in warfare with each other; there is, in fact, far less of friction in the work of transportation, and far more of system. Finally, as regards the community at large, it is found that large companies can be held to a closer responsibility than small ones. Their prominence enables public opinion to concentrate upon them—they are more closely watched and held to a stricter account."

In 1872 a committee was appointed by the Parliament of Great Britain to investigate and report upon the supposed evil of railroad amalgamation. From their report Mr. Charles Francis Adams, Jr., in his valuable and interesting work upon "The Railroad Problem," makes the following quotation: "The Northeastern Railway was composed of thirty-seven once independent lines, several of which had formerly competed with each other. Prior to their consolidation these lines had, generally speaking, charged high rates, and they had been able to pay but small dividends. Now, the Northeastern is the most complete monopoly in the United Kingdom; from the Tyne to the Humber it holds the whole country to itself, and it charges the lowest rates and pays the highest dividends of all the great English companies. It was not vexed by litigation; and while numerous complaints were heard from Lancashire and Yorkshire, where railroad competition exists, no one has appeared before the committee to prefer any complaint against the Northeastern."

Mr. Adams, in his comments upon the views and statements of this and other parliamentary committees appointed for similar purposes, concludes as follows: "The clearer political observers have come to realize at last that concentration brings with it an increased sense of responsibility. The larger the railroad corporation, the more cautious is its policy. As a result, therefore, of forty years of experiment and agitation, Great Britain has on this head come back very nearly to its point of commencement. It has settled down on the doctrine of *laissez faire*" (page 94).

If the facts were noticed, the American public could not long resist the same conclusion upon this subject that has been reached in

England. In commenting upon the favorable result of railway consolidation in Great Britain, the chief of the Bureau of Statistics, in his report upon the "Internal Commerce of the United States for 1881" (page 35), says: "A similar result has followed railroad consolidations in the United States. It has heretofore been shown that the average of all the rates charged on fifteen leading railroads of the country, including those of the great East and West trunk-lines, and the principal railroads west of the Alleghany Mountains, engaged in traffic between the Western and Northwestern States and the Atlantic sea-board, has decreased 39·45 per cent since 1870, this reduction in railroad freight charges having been more than three times as great as the average reduction during the same period in the prices of twenty-two of the leading articles of commerce."

This refers to those great trunk-lines against which there is the most frequent charge of monopoly, and upon which, singularly enough, there are the lowest average rates charged by any railroad on the earth.

Yet the objection to using these lines as an illustration of low rates voluntarily made by the companies with the object of increasing their traffic may be made with some appearance of fairness, as they are largely employed in moving the enormous products of the Western States to the sea-board, and the rates upon this portion of their traffic are controlled by the Great Lakes and the Erie Canal, and in part also, perhaps, by competition with one another. We may find an illustration, to which no objection of this kind can be raised, in the great California corporation.

The Central Pacific Railroad Company owns, or controls, with a few exceptions, all the railroads in California, and the western termini of three transcontinental lines. In an address to the people, by the National Anti-Monopoly League (page 15), the condition of railroad competition is stated here as follows: "Monopoly is growing in all the States. It has completely subjugated only one. In California it has ripened its fruit. There, Monopoly is king. There, a few men control steam-transportation. They have annihilated competition." This language has certainly the merit of being vigorous, and is well calculated to influence its hearers by its sound. "Subjugated," "king," and "monopoly," are words which in themselves excite a feeling of rebellion in the breast of a freeman; but, like many other sounding things, they are empty. This great system of roads, having crossed the trackless wastes and pierced the mountain-ranges, has brought a thriving population to thousands of square miles of land which theretofore were uninhabitable and without benefit to humanity. Since the first mile of track was operated by the owners of this company, the surplus earnings have been reinvested in extending its lines, and so increasing its benefits to the community.

Now let us see the effect of this absence of competition by other roads. Let us see if, as the consolidations and extensions have progressed, the rates have been raised, so that "there is not a producer that does not pay heavier tribute than conquered people ever paid their conquerors."* This is the common expectation and belief. I think there are many who will be disappointed to find that it is not true.

The Central Pacific charged, on its freight traffic in 1872, the average rate of 2·96 cents; † in 1881 this had been reduced to 2·16 cents; ‡ an average decrease in the past ten years of eight tenths of a cent on each ton hauled one mile. This is a reduction upon that local traffic which is commonly supposed to be beyond the control of any competition, as well as upon through traffic. This is shown by the fact that the increase of local tonnage for the period was 216 per cent, while the increase of receipts from the same source was but 162 per cent.# Had the average rate of 1872 been maintained by the company on its freight traffic for 1881, the receipts would have been $5,866,287 ‖ more in the latter year than they actually were. During this period of ten years, in which there has been a continuous reduction of rates, the competition by water has remained without change, and competition by rail has not existed; yet, under the control of the natural laws of trade, there has been such a reduction in the rates on frieght that it now amounts to the annual sum of over five and three quarter million dollars. This additional amount of earnings would have enabled the railroad company to pay a dividend, in 1881, of sixteen per cent, instead of the six per cent which was paid.

It should be observed, also, that the miles of road operated during the period under consideration have been increased from 1,158 in 1872 to 2,707 in 1881,^ a greater portion of which increase has been upon roads built through places almost entirely without inhabitants, and which, as a consequence, for the first few years could furnish but a limited traffic. It will at once be seen that the rates necessary, under such conditions, to pay the cost of service, must have been much higher than in districts where a population and trade already existed. The traffic on these newer portions of the road having been carried at rates which were justly, because necessarily, higher than over the older portion of the line, has had the effect of making the average rate of the whole, in 1881, much higher than it would have been had no new roads been built.

A fair consideration of these facts must, it seems to me, lead to the conclusion that there has been as great a reduction in the rates of this Western system of roads as has taken place in the same time upon any of the Eastern lines.

It is difficult to make any comparison between the operations of

* "Anti-Monopoly Address," p. 15.

† "Central Pacific Railroad Annual Report," 1872.

‡ Poor's "Manual," 1882, p. 868.

\# Computed from Annual Reports of the Company for 1872 and 1881.

‖ Poor's "Manual," 1882, p. 868. ^ "Annual Report," 1881, p. 16.

two systems having so few items of resemblance as the California company and the Eastern lines. Yet, if such comparisons are made, with the aim only of discovering the truth, and both systems are placed upon terms as nearly equal as circumstances will admit, there will appear as a result no contrast between the lines where there is the most complete competition and those which are popularly supposed to be controlled only by their own will.

The rates charged by the Pacific coast roads are, on the average, considerably higher than those of the great trunk-lines on the older and more thickly populated side of the continent. This statement presents a natural condition, for the circumstances are necessarily so different in regard to the volume of traffic that almost as great a difference is necessary in rates. The necessity of the difference compels the acknowledgment of its justice. It is obvious that, where a stated traffic will pay the expenses of operating the road and a fair rate of interest on the property, half of the amount of traffic must pay nearly twice the rates in order to produce the same result. Yet, if the popular belief is echoed by the press of California, the rates charged by the Central Pacific system are considered unreasonably high, because they are higher than the charges of the Eastern trunk-lines. The inequality and injustice of this basis of comparison are demonstrated by its application.

The lowest average rate in the United States has been reached upon those lines running between New York and Philadelphia and the West. The charges by these lines average less than one cent upon each ton of freight hauled one mile. Poor's "Manual" for 1881 (pp. 41–47) gives tables of the rates and cost of service of the New York Central, the Erie, the Pennsylvania, and the Pittsburg, Fort Wayne and Chicago Railroads, from which I have made the following comparative statement :

Comparative Statement of Freight Earnings, Expenses, and Traffic for the Year 1880.

	New York Central, 1,018 miles.	Erie, 1,010 miles.	Pennsylvania, 1,120 miles.	Pittsburg, Fort Wayne, and Chicago, 468 miles.	Central Pacific, 2,467 miles.[2]
Freight earn'gs, gross	$22,199,966	$14,391,115	$20,234,046	$7,359,452	$13,252,730[1]
Freight expenses....	13,670,884	9,188,297	10,892,368	4,069,097	5,976,448[1]
Freight earnings, net.	$8,529,082	$5,202,818	$9,341,678	$3,290,355	$7,276,282[1]
Freight earnings, per mile of road, net..	8,378	5,151	8,340	7,122	2,949
Tons freight carried.	10,533,038	8,715,892	15,364,788	3,865,675	2,140,879[3]
Tons carried 1 mile..	2,525,139,145	1,721,112,095	2,298,317,323	806,257,399	565,063,768[3]
Tons carried over each mile of road.	2,480,490	1,704,070	2,052,070	1,722,722	229,050
Average rate, cents..	$\frac{88}{100}$	$\frac{84}{100}$	$\frac{88}{100}$	$\frac{91}{100}$	$2\frac{34}{100}$[3]

[1] Report of the Central Pacific Railroad to the State Board of Railroad Commissioners, California, 1880 (unpublished).

[2] "Central Pacific Railroad Annual Report," 1881, p. 14.

[3] Poor's "Manual," 1881, p. 800.

The most conspicuous difference here shown is that between the tonnage of the Central Pacific and the Eastern roads. This must be considered in noticing the rates charged; for the revenue depends not so much upon what rate is charged as what it is charged upon. The average rate of these Eastern roads is $\frac{88}{100}$ of a cent, while the Central Pacific charge is $2\frac{34}{100}$ cents. But, on the other hand, the Eastern lines hauled upon an average, to each mile of road, 1,989,851 tons; which is a rather strong contrast to the 229,050 tons hauled by the Central Pacific. While the average rate of the Western company is two and a half times greater, the tonnage is eight and a half times less than on the Eastern lines. The difference in the rates thus seems to be more than counterbalanced by the great disparity shown in the traffic.

Among other inequalities which command consideration in any comparison of the rates of different roads is, in addition to the amount of traffic, the miles of road on which the traffic is carried. There must clearly be a great difference between the expenses of two lines, the one having 100 miles of road with a traffic of 10,000,000 tons, the other having 1,000 miles of road with the same amount of tonnage—supposing, of course, that the average distance each ton is hauled to be the same in either case. Many of the expenses, in connection with stations, etc., are nearly ten times as great in the latter as in the former case, while all the expenses of maintenance and operation are much greater with the longer than with the shorter line.

There is, of course, added to this, the consideration of the value of the property. A line, for instance, of 100 miles, representing $5,000,000 of value, would make, other things being equal, ten times the profit of a road of 1,000 miles, representing $50,000,000 of value. An equal amount of traffic upon roads between which such disparity exists places the shorter road at a great advantage in any comparison—it would make a larger net profit, though having a smaller capital.

Any approximation to an equality of conditions must thus recognize, in addition to the amount of traffic, the miles of road operated. Taking this into consideration, we find further that the average net earnings per mile of road operated, from the freight traffic on the above Eastern lines, is $7,285; and upon the Central Pacific it is but $2,949. We should consider, on the other hand, that, although the Central Pacific system of roads twice crosses the Sierra Nevadas, has many expensive tunnels and snow galleries that cost $40,000 a mile, yet the Eastern lines represent more value, as a portion of each road has double tracks, and the New York Central, for a distance of 236 miles, has even four parallel tracks.* Fully considering these differences, however, there still appears no such difference in the values as exists in the net earnings. The conclusion, therefore, seems fully justified, that, although the rates on the Central Pacific are greater, the net receipts are less, than on the Eastern lines; and the difference

* "Report of the New York Central Railroad to State Engineer," 1880, p. 9.

in rates is a necessary and natural result of the difference in the length of lines and the amount of traffic.

The differences, which appear in the above figures, between the lines mentioned, in the net earnings per mile of road operated, and in the tons of freight carried over each mile of road, will be more clearly realized with the aid of the following graphic method of comparative lines, which has been so well employed by Mr. Edward Atkinson:

Net Earnings from Freight, per Mile of Road.

N. Y. Cent..	$8,378
Pennsylvania	8,340
P., F.W. & C.	7,122
Erie.......	5,154
Cent. Pacific.	2,949

Tons of Freight carried over each Mile of Road.

N. Y. Cent..	2,480,490
Penn......	2,052,070
P., F.W. & C.	1,722,772
Erie.......	1,704,070
Cent. Pacific.	229,050

It would be easy to continue the comparison further, and show that the rates charged on the Eastern lines—whether fair or not upon them—would be unfair if applied to the Central Pacific; for, applied to the traffic of the latter, they would fall far short of paying the necessary expense of the service, while on the former roads they pay not only the expenses, but afford also a profit. But the foregoing facts, it seems to me, sufficiently show that there can be no satisfactory nor fair comparison between the rates on different roads, unless the amount of traffic and the length of line have in each case some approximation. Perhaps the most equitable test, by any comparison which it is possible to furnish of the charge of high rates made against the Central Pacific Company, is supplied by the railroads of Massachusetts.

Here, from the first railroad built in the United States, in 1826, to the present time, there has been a continuous extension of lines by various companies in all directions, till now, according to Mr. Atkinson, the Commonwealth has more miles of railroad in proportion to its territory than exists in any other State or country in the world. These roads represent sixty-four independent corporations.* Here, then, is the greatest contrast to be found between any two systems in regard to consolidation and that competition of parallel roads which is supposed to be the chief regulator of rates. There ought, therefore, according to the popular belief in these matters, to be a contrast equally as great between the rates of the different systems. Here, again, we shall find the popular belief to be in error.

The following table shows the freight earnings, traffic, and rates,

* "Massachusetts Report," 1879, p. 2.

and also the miles of road operated, by the Central Pacific system, compared with the Massachusetts roads:

Central Pacific.

YEARS.	Miles.	Earnings.	Tons one mile.	Rate.
				Cents.
1878........	2,119	$10,802,276	392,949,592	2·75[1]
1879........	2,319	10,934,574	449,580,783	2·43[2]
1880........	2,467	13,245,857	565,063,768	2·34[3]
1881........	2,707	15,842,139	733,285,889	2·16[4]
Average...	2,403	12,706,211	535,220,080	2·37[7]

Massachusetts.

YEARS.	Miles.	Earnings.	Tons one mile.	Rate.
				Cents.
1873........	2,365	$16,927,594	615,769,300	2·75[5]
1874........	2,418	15,771,689	597,085,805	2·64[5]
1875........	2,459	14,225,535	579,868,983	2·45[6]
1876........	2,479	13,644,278	628,577,176	2·17[6]
Average...	2,430	15,142,274	605,325,316	2·50[7]

[1] Poor's "Manual," 1879, p. 932.

[2] "Central Pacific Annual Report," 1879, pp. 20, 30. I find, upon examination and inquiry, that Poor's "Manual" for this year repeats the tonnage and rates of the previous year, in error.

[3] Poor's "Manual," 1881, p. 800.

[4] Poor's "Manual," 1882, p. 868. Poor states the rate for 1881 at 2·14 cents, which appears to be the result of an error in calculation. I take 2·16 cents, as calculated from data given.

[5] "Report of the Massachusetts Railroad Commissioners," 1875, pp. 126, 127.

[6] Ibid., 1877, pp. 188, 189.

[7] The rate given in each case is the average per ton per mile for *all* freights. (See "Massachusetts Report," 1877, p. 101.)

To arrive at the latest results the figures taken are for the last four years of the Central Pacific, but, in order to make an equitable comparison in the volume of the tonnage, it is necessary to take the Massachusetts roads for a few years previously. In any corresponding year the Massachusetts roads have a considerably larger tonnage than the Central Pacific; thus, as has been shown, making any fair comparison impossible. Even in the years given they have an annual average of thirteen per cent more tonnage than the Central Pacific, placing the latter system to that amount of disadvantage in the comparison.

On the other hand, however, is the consideration that the prices of material and labor necessary in the operation of railroads have been considerably reduced during the periods shown in the above table, but, in California, they have always been much higher than in the Atlantic States, and were probably higher in the former State in 1881 than they were in Massachusetts in 1876. The relative conditions seem, upon the whole, as fair as it is possible to make them between any two systems.

As a result, the following more important comparisons may be noticed: The average mileage of road operated is about the same in each case. While, on the Massachusetts roads, the average annual tonnage is thirteen per cent more, the earnings are nineteen per cent more, and the average difference in rates is $\frac{13}{100}$ of a cent more than on the Central Pacific system.

This brings us to the unexpected conclusion that, had the rates charged by the Central Pacific prevailed with the Massachusetts roads, it would have effected an annual saving to that State of $786,923, and this, notwithstanding the fact that the through freight, upon which the lowest rates always prevail, was fifty-eight per cent of the whole traffic in Massachusetts,* while upon the Central Pacific † it was but thirty-nine per cent.

It may be of interest to bring the affairs of this great corporation home to its own State, and see how it compares there with other roads which are independent of it.

In California, in 1878 ‡ (the last year for which statistics have been published), there were 1,170 miles of road, of which 844 miles were controlled by the Central Pacific, and 326 miles were of small roads, none of which were of sufficient magnitude to create envy or gain the appellation of monopoly. The average rates of eleven of these shorter roads, representing 248 miles, are stated by the State Commissioner of Transportation, from whose report I take the following figures :

Table of Rates on Railroads not controlled by the Central Pacific Railroad Company, reported by the Commissioner of Transportation of California, for the Year 1878.

Miles of road operated. Table II.	NAME OF ROAD.	AVERAGE RATE. Freight, per ton (Table XV.)	AVERAGE RATE. Per passenger. (Table XV.)
		Cents.	Cents.
6·	Black Diamond Coal Company	33·33	8·33
26·50	California Northern	5·86	7·50
5·33	Pittsburg	9.	....
106·24	San Francisco and Northern Pacific	....	3·91
29·	Vaca Valley and Clear Lake	7·	8·
4·	Mendocino	7·87	....
22·64	Nevada County Narrow-Gauge	16·89	8·14
10·67	San Luis Obispo and Santa Maria Valley	15·	8·
21·16	Santa Cruz	9·	7 50
9·	Santa Cruz and Felton	8·19	....
7·33	Visalia	....[1]	10·
247·87	Total miles.		
	Average rates	12·46	6·82

[1] For the Visalia Railroad, the average rate for freight stated in the report of the commissioner is $1\frac{1}{2}$ cent. This, upon examination, proves to be an error. In the same report, p. 183, the highest rate is stated at $68\frac{2}{11}$ cents, the lowest at 2 cents, and the average $1\frac{1}{2}$ cent. This is, of course, impossible. In the report of the previous

* "Massachusetts Reports." † "Central Pacific Railroad Annual Reports."

‡ Report of Commissioner of Transportation, Table II.

commissioners, for June 30, 1876, p. 132, the highest rate is stated at $68\frac{2}{11}$ cents, and the lowest at $6\frac{7}{11}$ cent. I have, therefore, omitted the rate given of $1\frac{1}{2}$ cent from the above table.

As these short lines are supported entirely by local traffic, a proper comparison of their rates with those of the Central Pacific should consider only the local rates of the latter. The commissioner, in the same table, furnishes us with these, so that we are enabled to make the following comparison:

The average charge per passenger per mile was, on the short lines, $6\frac{82}{100}$ cents; on the Central Pacific (for local only), $2\frac{83}{100}$ cents. The average charge per ton of freight per mile was, on the short lines $12\frac{46}{100}$ cents; and on the Central Pacific—for local only—$3\frac{26}{100}$ cents.

Here, again, the facts show that this great California corporation, which is charged by the Anti-Monopoly League with constant and destroying extortion, has much lower average rates than these smaller companies which are not conspicuous enough in size or wealth to draw the attention of the press or the attacks of politicians.

The tendency of railroad ownership and management has from the beginning been toward amalgamation. This is apparent to all, and is popularly termed the growth of monopoly. The facts that have herein been presented all tend to illustrate the truth that this amalgamation has been accompanied by as constant a reduction of rates. The so-called "monopoly" is thus shown to be exactly the opposite of those privileged corporations which, in the past centuries, have given the word its evil significance: for, without any special or exclusive privilege, the railroad is in itself an institution which naturally secures whatever monopoly it has of the business of transportation by the superior advantages and cheapness which it affords. With the reduction of rates, therefore, the "monopoly" must increase; for the reduction of rates means an increase of traffic.

The reduction of rates, however much it may be influenced by the competition of parallel lines, is absolutely controlled by the operation of those great natural laws which govern all commercial transactions. These laws are summed up in the statement, made some years since by the President of the Central Pacific Railroad Company, that "the interests of the railroad and the community are identical." The prosperity of the former is absolutely dependent upon the prosperity of the latter; and the development of the industries and the increase of the products of the communities depend upon cheap transportation, perhaps more than upon any single thing. It becomes, therefore, not only the interest of the railroads to furnish cheap transportation, but they are led also to the same action in their efforts to increase their net income. As the ratio of expenses decreases with the increase of traffic, a reduction of rates which secures an increase of traffic thus produces an increase of net profit. Consolidations, by reducing the ratio of expenses, make possible the greater reduction of rates; and great corporations, having their interest connected with wider and more extended territory, have broader views in their management, and are guided by policies which tend more to the healthful and permanent development of their properties and the territories which they depend upon for their revenue. The facts, in America as well as in Europe, fully confirm the statement of the Parliamentary Committee of Great Britain, that amalgamations result in furnishing better service, lower rates, and higher dividends—a benefit to all alike.

In the popular mind, the solution of the railroad problem is based upon the fundamental misconception that the so-called railroad "monopolies" raise the tariffs at their pleasure, are controlled only by their own wills, and so, influenced alone by selfish interests, they maintain unreasonably high or extortionate rates. Yet, it will always be found that, in seeking to advance their own interests, they are absolutely controlled by those general economic laws through the operation of which every one is seeking his own good, under terms as nearly equal as is allowed by nature itself; and their interests can only be advanced by advancing also the interests of their patrons. Freight will only be shipped when its transportation results in a profit to the shipper. The greater this profit, or the more it is extended to all articles of trade, the greater is the traffic; and the greater the traffic of the railroads, the greater is their profit. Under the operation of natural laws, each, in seeking its own interests, must advance also the interests of the other; this result can only be changed when the laws of nature are suspended by the legislation of man.

The railroad, heretofore generally untrammeled by restrictive legislation, has been productive of more beneficent results to the country at large than the most sanguine enthusiast of a generation ago would have dreamed. As it is a human institution, it has contained also the faults common to humanity. These, experience and interest will in time reduce to a minimum; and, guided by the same laws which in the past have produced so favorable results, its future operations must constantly work toward the greatest good of the greatest number.

QUEER PHASES OF ANIMAL LIFE.*

By FELIX L. OSWALD, M. D.

OUR nearest relatives in the large family of the animal kingdom are undoubtedly the frugivorous four-handers, with some of their nocturnal congeners, but it would be difficult to classify the quadru-

* This article is made up from the text of Oswald's "Zoölogical Sketches" (noticed in our pages last month), by permission of the publishers of the volume, Messrs. J. B. Lippincott & Co., of Philadelphia, to whose courtesy we are also indebted for the accompanying illustrations.—Eds. P. S. M.

mana after the degree of that relationship: no naturalist could name the most man-like ape. It is a *reticulated* rather than a graduated system of affinity, as Carl Vogt expresses it; the type of the human form is a center from which the connecting lines diverge in various directions. To every supposed characteristic of our physical structure some genus or other of the multiform family has been found to exhibit a parallel; only the combination of these attributes distinguishes man from all monkeys.

The Latin word *simia* is derived from *simus* (flat-nosed), and Ælian considered the prominence of the human nose as a prerogative of our species; but Sir Stamford Raffles discovered a nose-ape, the Bornean representative of the genus *Semnopithecus*, a big, long-tailed brute, with a truly Roman proboscis and the narrow nostrils of the Caucasian race. In proportion to his size, the white-handed capuchin-monkey of Western Guiana has a higher forehead than the two-legged inhabitants of his native woods; and the anatomist Camper demonstrated that, with respect to the length of the tail-bones, immortal man forms the connecting link between the lower apes and the orangs. The Arabs, who question the human pedigree of the beardless Ethiopian, would have to hail the wonderoo as a man and a brother; and the male orang-outang, too, can boast of a chin-tuft that would do credit to a modern senator.

It would, indeed, be a mistake to suppose that all monkeys are naturally mischievous. The little Tamarin (*Midas rosalia*) handles its playthings more carefully than most children, and the females, especially, seem almost afraid to stir without their keeper's permission. Gratuitous destructiveness is rather a distinctive trait of the African quadrumana, and their representative in this respect is, perhaps, the *Cercopithecus maurus*, the Moor-monkey, or *monasso*, as they call him in Spain, a fellow who seems to consecrate his temporal existence to mischief with an undivided and disinterested devotion. This maurus and his cousin, the rock-baboon, are the terror of the Algerian farmer; but the baboon contents himself with filling his belly, while the other tears off twenty ears of corn for one he eats, and often enters a fig-garden for the exclusive purpose of stripping the trees of their leaves and unripe fruit. In captivity he can not be trusted even with a leather jacket, and, finding nothing else to spoil, does not hesitate to exercise his talent upon his younger relatives, to the detriment of their woolly fur. Still, his intelligence and restless activity make him a prime favorite of the fun-loving Spanish sailors, and in the Andalusian sea-ports every larger household has a monasso or two—*monos de cadena*, "chain-monkeys," as the dealers call them, a Moor-monkey and a *cadena* being as necessary concomitants in civilized regions as a king and a constitution. A rupture of the concatenation creates an alarm, as if the chained beast of the Apocalypse had broken loose, and, if an unchained monasso gets a five minutes' chance at a kitchen or a parlor, he can be relied upon to commit all the havoc a creature of his strength could possibly execute in five times sixty seconds ; an instinct bordering on inspiration seems to tell him at the first glance where and how to perpetrate the greatest amount of actual damage in the shortest possible time. In a harbor-hotel of Cartagena I saw a mono whose terpsichorean talents had made him a more than local celebrity. He could dance the Moorish *zameca*, besides the bolero and fandango, and was sometimes released at the request of his admirers, who pitied his constant collisions with the lock of his drag-chain ; but on such occasions the landlady used to charge a *real* extra, for even her presence did not prevent the mono from indulging his ruling passion. Under pretext of returning the caresses of his visitors, he managed to abstract their buttons, upset a flower-pot or two, or interrupted his performances to make a grab at a litter of poodle puppies on the veranda. His scar-covered skull proved that the lot of the transgressor is hard ; but the

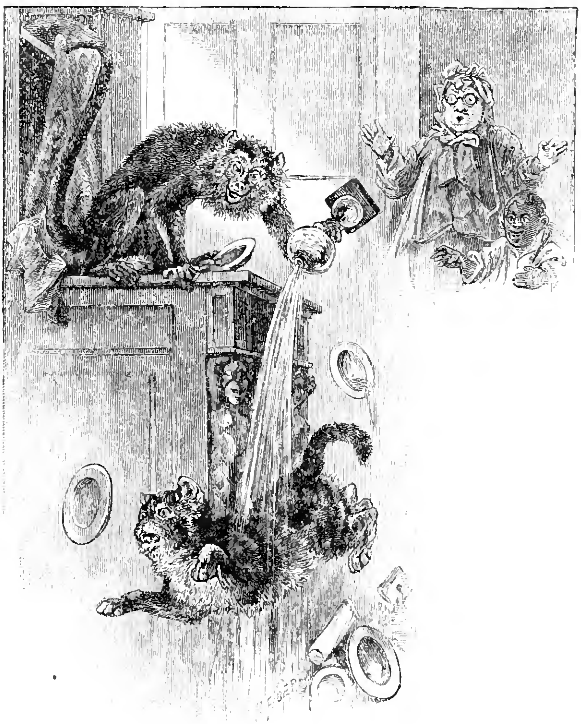

FIG. 1.—TOTAL DEPRAVITY.

depilated condition of his neck was owing to a peculiar trick of his, as the *posadera* explained it. He would hug a post near his couch under the veranda, and, stretching his head back and his tongue out, would twist his neck to and fro, as if in the agonies of strangulation.

During a temporary absence of their mother he once succeeded in deceiving the children by these symptoms of distress; they loosened his chain-strap an inch or two, but happily took the precaution to shut the house-door and the cellar-gate. But they had forgotten the poultry-house; and when the lady returned in the evening her sixteen hens had been converted into Platonic *homunculi*—"bipeds without feathers and without the power of volitation." On another occasion he came near setting the house on fire by drenching the cat with the contents of a large kitchen-lamp. Still, after trying sundry other four-handers, the lady declined to part with her monasso, though she lamented his utter want of principle, like the *Devin du Village:*

"Hélas! que les plus coupables
Toujours sont les plus aimables!"

The anthropoid apes are a somewhat taciturn race, but a chimpanzee's murmur of affection is very expressive, and quite different from his grunt of discontent. A sick orang-outang sheds tears, moans piteously, or cries like a pettish child; but such symptoms are rather deceptive, for the orang, as well as the chimpanzee, is a great mimic, not of men only, but of passions and pathological conditions. Two years ago I took temporary charge of a young chimpanzee who was awaiting shipment to the Pacific coast. His former landlord seemed to have indulged him in a *penchant* for rummaging boxes and coffers, for whenever I attempted to circumscribe the limits of that pastime my boarder tried to bring down the house, metaphorically and literally, by throwing himself upon the floor and tugging violently at the curtains and bell-ropes. If that failed to soften my heart, Pansy became sick. With groans and sobs he would lie down in a corner, preparing to shed the mortal coil, and adjusting the pathos of the closing scene to the degree of my obstinacy. One day he had set his heart upon exploring the letter department of my chest of drawers, and, after driving him off several times, I locked the door and pocketed the key. Pansy did not suspect the full meaning of my act till he had pulled at the knobs and squinted through the key-hole, but, when he realized the truth, life ceased to be worth living: he collapsed at once, and had hardly strength enough left to drag himself to the stove. There he lay, bemoaning his untimely fate, and stretching his legs as if the *rigor mortis* had already overcome his lower extremities. Ten minutes later his supper was brought in, and I directed the boy to leave the basket behind the stove, in full sight of my guest. But Pansy's eyes assumed a far-off expression; earth had lost its charm; the inhumanity of man to man had made him sick of this vale of tears. Meaning to try him, I accompanied the boy to the staircase, and the victim of my cruelty gave me a parting look of intense reproach as I left the room. But, stealing back on tiptoe, we managed to come upon him unawares, and Pansy looked rather sheepish when we caught him in the act of enjoying an excellent meal.

In Hindostan monkeys enjoy all the privileges of a Mohammedan lunatic, being permitted to rob the orchards with impunity, decimate the rice-crop, and rob all the birds'-nests they want; but, not content with levying out-door contributions, they pillage the cottages of the natives while the proprieters are at work in the fields; nay, they often manage to despoil the larder of the foreign residents, or black-mail their children if they leave the bungalow with a lunch-basket or a pocketful of nuts.

The Rev. George Thielmann, of the Moravian mission, who passed several years in the Eastern Punjaub, describes the despair of his German cook at the impudence of the light-fingered gentry. "I do not see how the natives can stand it," said she; "if they take those baboons for Christians, they ought to have a penitentiary in every village." If she went to the door to answer a bell, the macaques entered the kitchen through the rear window; going to look after her sun-dried peaches, she found that the Bhunder apes had been beforehand with her; and if she left her bedroom-window open she was awakened

Fig. 2.—Misplaced Confidence.

by a committee of Honumans taking an inventory of her wardrobe. One day she left the gardener's dinner under a tree where he used to take his *siesta*, but, returning with a dessert of German doughnuts, she was just in time to see a troop of Rhesus baboons running off with the dishes and bottles.

From the moment that a young monkey is weaned he has to steal, for Dr. Brehm's observation applies strictly and literally to every species of quadrumana; the mother-monkey robs her own child, and forces it to eat its food by stealth. The proprietor of the "Zoölogical Coffee-Garden," in Savannah, Georgia, has been very successful in rearing young monkeys, and the visitors of his happy-family department can witness the same scene thrice a day—a number of half-grown capuchin babies fleeing from the wrath of their own parents. As soon as the dinner-bucket is brought in, the youngsters hide in the corner and watch their opportunity, for while their seniors are feeding there is no hope of a crumb or a drop of milk; but sooner or later the old ones are sure to fall out, and during a general scrimmage for a tidbit the children sometimes get a chance at the bucket, and take care to make the best of it. But woe unto them if their progenitors catch them *in flagranti!* Sires, mothers, and aunts combine to avenge the sacrilege, and the noise of the punishment often sets the whole menagerie agog. I have seen a she-macaque jamming her bantling up against the wall and extracting from its cheek-pouches the gifts of a charitable visitor, together with all the crumbs and scraps the little one had gleaned from the floor, and then adding outrage to injury by cuffing the victim's ears.

The English word stalwart is derived from *stael-worth*—i. e., *worth stealing*; and the same criterion seems to be a monkey's standard for the value of earthly things in general. Any novel, movable, and portable object at once excites his interest. If the digestible qualities of the novelty seem doubtful, he appears to act on the principle that in the mean while it can do no harm to appropriate it. North of the Rio Grande most capuchin-monkeys are martyrs to rheumatism, and three poor cripples of the Cebidæ species had been assigned winter-quarters in the kitchen of a New Orleans boarding-house. They could be trusted, as their complex ailments disqualified them from running and climbing, their only mode of progression being a sidelong wriggling on their haunches and elbows. But one day the landlady heard a frightful caterwauling, and, entering the kitchen in haste, was surprised to see one of her patients on top of the chimney-ladder, while another was rolling about in a fit of fantastic contortions. The cook had left on the floor a bucketful of Pontchartrain crabs, and during her momentary absence the monkeys had fallen victims to the cause of free inquiry. Somehow or other the cook's manœuvres had drawn their attention to the bucket, and, having managed to upset it, their ring-tails had got entangled with the not less prehensile crustaceans.

The tardo (black sloth) has a peculiar talent for making himself invisible. Even a medium-sized tree, without an excessive supplement of tangle-vines, has to be inspected thoroughly and from different points of view before a slight movement in the upper branches attracts your attention to a fluffy-looking clump, not easy to distinguish from the dark-colored clusters of the feather-mistletoe (*Viscum rubrum*) which frequents the tree-tops of this mountain-region. Closely resembling clusters of feathery leaves and feathery hair are often seen side by side on the same branch. Which of them is the animated one? A load of buckshot may fail to settle the point. I have seen a troop of

FIG. 3.—MARTYRS TO FREE INQUIRY.

idle soldiers bombarding a sloth-tree for half an hour with the heaviest available missiles without being able to force the *stronghold* of the occupant, who only tightened his grip when a well-aimed stone crushed his head visibly and audibly. But with a good rifle you may dislodge the most tenacious tardo by hitting his branch somewhere below his foot-hold, for a fractured caucho-stick will snap like a cabbage-stalk. Thus displanted, the falling sloth clutches at the empty air or snaps off twig after twig in his headlong descent, but generally manages to fetch up on one of the stout lower branches, and at once hugs it with all the energy of his prehensile organs; and there he hangs, within easy reach of your arm, perhaps, but without betraying the slightest concern at your approach. The human voice has no terrors for the stoic tardigrade; menacing gestures fail to impress him. A blank cartridge exploded under his nose will hardly make him wink, unless the powder should singe his eyelids. He permits you to lift his claw, but drops it as soon as you withdraw your hand. If you prod him, he breaks forth in a moan that seems to express a lament over the painfulness of earthly affairs in general rather than resentment of your particular act. By-and-by his love of caloric may lure him back to the sunny side of the tree, but no incentives *a tergo* will accelerate his movements. His claws are a quarter of a foot long and rigidly tenacious, and, once unhooked, he forthwith transfers his attachment to your own person. After spreading his talons fan-shape, he clasps your arm with an intimacy that seems intended to reassure you of his peaceful intentions, but will gradually draw himself well up, as if unwilling to interfere with your locomotive facilities.

But, as Stanislaus Augustus said from sad experience, "Innocence is no excuse before the tribunal of war," and, in the tropics at least, a state of nature is a state of incessant warfare. In spite, therefore, of all his precautions and his monopoly of an almost unlimited food-supply, the sloth is found nowhere in great numbers; his enemies are too many for a creature that can neither fight nor fly. The harpy-

Fig. 4.—A New Departure.

eagle skims the tree-tops of the *tierra caliente*, or falls upon him like a flash from the clouds; the lynx lurks in the twilight of the shade-trees; the sneaking ocelot explores the inmost penetralia of the liana-maze; if he meets him, he meets his death. Carnivora have to combine caution with sudden swiftness to catch a monkey in day-time, but sloth-hunting is a search rather than a chase; small palm-cats or sluggish bears may take a morning ramble through the branches of his chosen tree, and, if they espy the poor leaf-eater, his capture follows as a matter of course; they need not pursue him, they can collar him at their leisure; a hungry bear collects a family of sloths as he would gather a bunch of grapes.

Still, Fate has granted the much-bereft edentate one compensation—a cheap one, indeed, but still an offset to many defects—a most contented disposition. On the morning of an unusually cold April day I was summoned to a neighboring town, and took a look at my tool-house menagerie before I left. Finding that the female sloth had monopolized the family couch, I carried her mate up to an empty garret, and attached his claws to a mantel-piece, where he could warm himself by putting his back against a flue of a hot-air chamber. An unexpected delay prevented my return that night, and when I got home the next morning I entered the garret with sore misgivings about the survival of my tardo. But, no; there he hung, on the very same spot and in the same attitude, imbibing caloric at every pore, and purring to himself in dreamy beatitude—a tardo temporarily satisfied that life was worth living.

A striking contrast to the sluggishness of the sloth is presented by Dr. Oswald's description, in another part of the book, of the Honuman monkey at play.

Without wings, agility could hardly go farther; from the standpoint of a practical anatomist, it is almost inconceivable how muscles and sinews, apparently so very similar to our own, can execute such movements. Without the least visible effort, the marvelous half-bird darts through the air in a wide zigzag, merely touching a branch here and there; upward suddenly with a series of mighty swings, regardless and apparently forgetful of obstacles; down with a gradationed spring that looks like a single leap; up again with a flying rebound through a tangle-work of branches, yet at the same time watching his comrades, aiming and parrying slaps or dodging a shower of missiles; then, with a sudden grab, a quick contraction of the hind-legs, and the acrobat sits motionless on a projecting branch, watching a movement in the grass that has not escaped his eye during his headlong evolutions.

A bat is a living anachronism; there is something obsolete and paradoxical in every part of its organization. Skin wings were quite in vogue in the days of the Devonian monster-period, but have gone out of fashion among the representative creatures of our latter-day world; and it is a curious fact that all winged mammals have become nocturnal, as if they could not compete with the talents of their daylight contemporaries. The winged lemur (*Galeopithecus volans*), the flying-fox, and the flying-squirrel, are all moonshiners, and dread sunlight as miracle-mongers dread the light of science; but they all have the exaggerated optics of an owl, evening-eyes, that catch every ray of the fading twilight, while the eyes of the bat proper are as rudimentary as those of a mole, or of the strange fishes that were discharged from the subterranean tarns of Mount Cotopaxi.

As the Euclidean *punctum* is defined as a point without extension, the voice of a bat might be called a sound without vibrations—a shrill, sudden squeak, unlike any other sound in nature or art. Though piercing enough to be heard from afar, it is too abrupt to guide the ear in any special direction; you can put a wood-bat in a narrow box, and the box on the table, and bet large odds that the incessant shrieks of the captive will not betray its hiding-place; to nine persons out of ten the sound will seem to come from all parts of the room at once.

Many of their habits, too, distinguish the cheiropters from all other creatures of our planet. Aristotle classed them with the birds; and in one respect they might even be considered the representatives of the class, being *par excellence* creatures of the air. All winged insects can run or hop; the sea-gull runs, swims, and dives; but, with the sole exception of the Javanese roussette, bats are completely "at sea" in the water, and almost helpless on *terra firma;* they eat, drink, and court their mates on the wing, and the *Nycteris Thebaïca* even carries her young on her nightly excursions. Nay, bats may be said to sleep in the air, for they build neither day-nests nor winter-quarters, but hang by the thumb-nail, touching their support only with the point of a sharp hook. But this hand-hook connects with muscles of amazing tenacity. In cold climates, where bats have to club together for mutual warmth, fifty or sixty of them have been found in one bundle, representing an aggregate weight of about fifteen pounds, all supported by one thumb-nail! The "head-centers" must sleep as warm as a child in a feather-bed; but it is hard to understand how the outsiders can survive the cold season, for, in spite of its voracity, the bat accumulates no fat, and the flying-membrane is a poor protection against a North American winter. The only explanation is that their winter torpor is a trance, a protracted catalepsy, rather than a sleep; hibernating bears and dormice get wide awake at a minute's notice, but I have handled bats that might have been skinned without betraying a sign of life, and needed more than the warmth of my hands to revive them, for their wings were quite brittle with rigid frost. Bats prefer a cave with tortuous ramifications that shelter them against direct draughts, but still with a wide though not too visible opening, as they do not like to squeeze themselves through narrow clefts. A dormitory combining these requisites is sure to attract lodgers from far and near; the northern entrance of the tunnel-grotto of Posilippo and the Biels-Höhle in the Hartz are tenanted by hundreds of thousands of bats that avoid all the neighboring caverns; and our Mammoth Cave, with its countless grottoes, has only two bat-holes, whose occupants have never been known to change their quarters.

FIG. 5.—CHILDREN OF EREBUS.

Nearly all the South Asiatic vegetarians treat mischievous animals with a more than Christian forbearance; but the worshipers of Brahma have, besides, been taught to regard certain species of the brute creation as half divine, and consequently altogether inviolate, and entitled to the active charity of every true believer—the most privileged of the zoölogical demi-gods being the bhunder-baboon (*Papio Rhesus*), the Honuman (*Semnopithecus entellus*), the Brahmin cow, the pigeon, and the common crocodile. In Hindostan the public spirit of wealthy philanthropists rarely rises above the orthodox conservatism of the national mind; bequests are not devoted to public improvements, but rather to the maintenance in *statu quo* of incorporated societies and multitudes of secular and clerical mendicants; and Sir Emerson Tennent estimates that the produce of fully ten per cent of all the stipends of a most charitable population of one hundred and sixty millions is consecrated to the support of lazy or mischievous brutes.

Like Italian lazzaroni, city baboons live in cliques—clannish communities, very exclusive in times of scarcity, and always rather dis-

Fig. 6.—Four-handed Lazzaroni.

inclined to enlarge their membership except by natural increase and advantageous alliances, as with fat house-baboons with a roving disposition. Four-handed vagrants are promptly stopped and cross-examined: no mercy for the homeless stranger suspected of speculating upon a share of their scanty sportules, while the household pet with his brass collar and sleek pouch is merely scrutinized with silent envy. The half-grown bhunder-monkeys are so pretty that they are often domesticated, but their relatives dislike to part with them—from motives that have nothing to do with "philoprogenitiveness."

The holy children are their mediators, their apple and bread winners. The entreaties of the little beggars are not easy to resist: they will climb you after the manner of pet squirrels, embrace you with one arm and beg with the other, accompanying their gestures with a deprecatory mumble that becomes strangely expressive, as if they were pleading extenuating circumstances, if you offer to strike them. Even the idol-hating Mussulman is thus often beguiled into a liberality which his conscience may be far from approving. If the little spongers have struck a bonanza, they swallow *in situ* all they can find room for, well knowing that upon their return the contents of their cheek-pouches will be claimed by their relatives, for even a mother-monkey has no hesitation in plundering her own child in that way. To avoid coercive measures, the poor kids surrender their savings voluntarily and with great dispatch at the approach of the ruthless parent. Like our artist-mendicants who keep a beggar-boy *ad captandum*, old baboons sometimes kidnap a baby of another tribe, keep a strict watch on its movements, but urge it with slaps and grunts to work the passers-by. Crippled baboons, too, are a most welcome acquisition to any clique. These twice-worthy objects of charity have their regular head-quarters, where they can be found at any time of the day surrounded by eupeptic relatives who hope to participate in the largess of the pious. The poorest huckster will stop his cart in a gate-way to hand his tribute to a decrepit bhunder-monkey who supplicates him with outstretched hands. No true believer must stint his gifts upon such occasions; and so well does the hairy mendicant know the stringency of that duty that he flies out into a paroxysm of virtuous wrath if any passer-by should dare to disregard his appeal. The relatives promptly yield their aid, and fruit-carts are in danger of being monkey-mobbed if the driver hesitates to propitiate their resentment by a liberal contribution.

In a sparsely settled but tolerably fertile country animal refugees soon accustom themselves to the vicissitudes of their wild life. The ten months' drought of 1877, which almost exterminated the domestic cattle of Southern Brazil, was braved by the pampa cows, whom experience had taught to derive their water-supply from bulbous roots, cactus-leaves, and excavations in the moist river-sand. Solid food is only a secondary requirement; with a good supply of drinking-water many animals would beat Dr. Tanner's time. But how the Syrian Khamr dogs manage to make out a living only the gods of the desert know. They rough it in regions where no human hunter would discover a trace of game, and where water is as scarce as in the eternal abode of Dives; nay, they multiply, for the Khamr bitch, like other poor mothers, is generally overblessed with progeny; six youngsters a year is said to be the minimum. A sausage-maker would probably decline to invest in Khamr dogs; the word *leanness* does not begin to describe their physical condition; *strappedness* would be more to the purpose, if an Arkansas adjective admits of

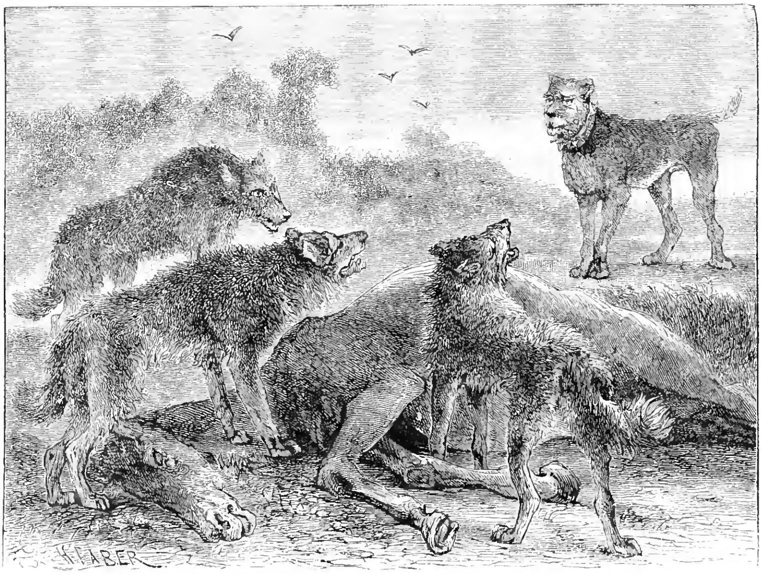

Fig. 7.—Wild Dogs.

that suffix—skin and sinews tightly strapped over a frame-work of bones. I saw their relatives in Dalmatia, and often wondered that they did not rattle when they ran; but Dalmatia is still a country of vineyards and sand-rabbits, while the Syrian desert has ceased to produce thorn-berries. Without moisture not even a curse can bear fruit.

Where food is plenty, wind and weather seem to modify the *physique* of a tramp animal. Most wild dogs are bushy-tailed, gaunt, and fox-headed, and for some occult reason almost invariably *black-muzzled.* It is their clan-mark: judging from the snout alone, few naturalists would be able to distinguish a tramp-dog from the pampa cur, the Khamr hound, the dog-wolf (*Canis anthus*), or the Abu Hossein (*Canis lupaster*). It does not improve their appearance; in connection with their wolfish eyes, it reminds one too much of a hyena-head.

The question whether there are any *untamable* animals requires a nearer definition of the somewhat ambiguous adjective. Untamable, in the sense of undomesticable, I believe there are none. With the proviso of a guarantee against socage-duty or a change of their natural habits, few animals would decline the hospitality of the *homo sapiens,* especially in countries where the sapient one has become the monopolist of all the good things of this earth. Let any one sweep the snow from his balcony, scatter the cleared space with crumbs, and put the balcony-key where the children can not find it, and see how soon his place will become the resort of feathered guests—not of town-sparrows only, but of linnets, titmice, and other birds that are rarely seen out of the woods. A little discretion will soon encourage them to enter the window and fetch their lunch from the breakfast-table—by-and-by even in the presence of their host—for the fear of men is a factitious instinct, unsupported by the elder intuition that teaches animals to distinguish a frugivorous creature from a beast of prey. With so simple a contrivance as a wooden box with a round hole, starlings, blackbirds, martins, crows, jays, and even owls, can be induced to rear their young under the roof of a human habitation; squirrels, hedgehogs, and raccoons soon find out a place where they can get an occasional snack without having to pay with their hides. Hamman, the famous German skeptic, used to feed a swarm of sea-gulls, often the only visitors to his lonely cottage on the shore of the Baltic. The neighbors suspected him of necromantic tricks, but he assured them that his whole secret consisted in never interfering with his guests—keeping a free lunch on hand, and letting them take their own time and way about eating it.

The same magic had probably bewitched the pets of Miss Meiringer, the daughter of a German colonist of New Freyburg, Brazil. Her father was a self-taught naturalist, and his collections have been described by several South American travelers; but in the opinion of the natives his curiosity-shop was eclipsed by the menagerie of his daughter, who had tamed some of the wildest denizens of the forest, though evidently on the *suaviter in modo* plan, since most of her pets boarded themselves, or only took an occasional breakfast at the *fazenda*. Among her more regular guests were a couple of red coaties, or nose-bears, several bush-snakes, and one large boa, a formidable-looking monster with the disposition of a lap-dog, for at a signal from his benefactress he would try to curl himself up in her apron, with a supernumerary coil or two around her knees.

There is hardly any doubt that animals must possess some means of communicating their ideas. Arsenic has no perceptible taste or odor, and an ounce of it mixed with a bushel of corn-meal will destroy a cart-load of sewer-rats in a single day; but all professional vermin-killers agree that such receipts lose their efficacy in a very short time. Somehow or other the survivors manage to trace the mischief to its cause; and old rats have been observed in the act of driving their young from a dish of poisoned hash. When the British first effected a settlement in Singapore, the traffic in monkeys soon became a regular branch of industry. The ubiquitous Chinamen used to go on trap-

Fig. 8.—Strange Messmates.

ping expeditions to the hills, at a time of the year when the mountain macaques were rather hard up for provisions and could be baited with "fuddle-cakes"—i. e., rice-bread soaked in a mixture of sugar-and-rum. The trapper used to hide behind a tree, and let the monkey assemblage enjoy his bounty till their antics suggested that it was time for him to rush in, like Cyrus into the banquet-hall of Belshazzar. Experience, however, soon taught the little mountaineers to change their tactics. Instead of devouring the fuddle-cakes on the spot, they learned to gather them up and defer the feast till they reached a retreat where they could hope to be left alone in their glory. But the trappers, too, have since changed their plan. They manufacture a sort of narrow-necked jars, about the size of sarsaparilla bottles, and, after filling them with a *mélange* of sirup and alcohol, they tie them firmly to the root of a tree and withdraw out of sight. The monkeys come down and sip the nectar, a little at a time, till many a mickle has muddled their perceptives to the degree which the founder of Buddhism would have called the first stage of *Nirvana*—indifference to earthly concernments in general. The trapper then approaches and collects his guests, whose exalted feelings often manifest themselves in a peculiar way. Some receive their captor with open arms, some hug their bottles with ap-

Fig. 9—The Wages of Sin.

probative grunts, while others lie on the ground, contemplating the sky in ecstatic silence.

Practical naturalists are generally the most successful trappers, for Lord Bacon is probably right, that observation is quite as prolific a mother of inventions as necessity. Only observation could have revealed the fact that little song-birds can be attracted by the sight of a bird of prey. A common chicken-hawk will serve that purpose. Fasten a tame hawk to a bush, and before the end of an hour all the finches and thrushes in the township will find it out and meet in general convention—an indignation-meeting, perhaps—though it is hard to understand what they can hope to accomplish against an enemy who could kill a score of them in ten minutes. But the experiment never fails: a hawk, an eagle, but especially a ferocious-looking old horn-owl, will allure birds at a time when they would disdain to neglect their domestic business for the sake of any tidbit. An owl-riot they seem to consider as a sort of public duty which must take precedence of all other affairs, for even migratory birds will stoop from their flight through air and light to screech around an old night-spectre. In Northern Italy, where game is scarce, every farmer has a tame *buba*

Fig. 10.—Decoy Owls.

and a potful of bird-lime, and thousands of northern songsters, hastening fondly home from their winter-quarters on the Mediterranean, fall a victim to their ruling passion and perish in exile—"butchered to make a Roman holiday."

"NATURAL RELIGION."

A STUDY IN THE GROWTH OF SCIENTIFIC MORALITY.

By R. W. BOODLE.

II.

THE preliminary discussion of last month enables us to speak now more directly of the work on "Natural Religion." Its writer is clearly himself a believer in supernaturalism, if not as very tangible, yet as an underlying possibility. He begins by stating the problem before us: "Two opposite theories of the universe are in conflict. On the one side is the greatest of all affirmations, on the other the most fatal of all negations. There never yet was a controversy which was not trivial in comparison with this. It is cruel trifling to speak of compromise, it is waste of time to draw verbal distinctions." And then, after two hundred pages of verbal distinctions, many of which are really no better, a compromise is effected upon the basis of natural religion, which is also natural Christianity without its supernaturalism. But the writer has no wish to deceive either himself or his readers, and concludes, "Who will not say that a supernatural religion, supplementing a natural one, may be precious, *nay, perhaps indispensable?*" And indispensable he shows it to be, from his own point of view: "When the supernatural does not come in to overwhelm the natural and turn life upside down, when it is admitted that religion deals in the first instance with the known and the natural, then we may well begin to doubt whether the known and the natural can suffice for human life. No sooner do we try to think so, than pessimism raises its head. . . . A moral paralysis creeps upon us. . . . Supernatural Religion met this want by connecting Love and Righteousness with eternity. If it is shaken, how shall its place be supplied? And what would Natural Religion avail then?" We have, then, to remember that this attempt to establish a harmony between orthodoxy and the votaries of art and science, upon the minimum basis of a faith without a personal God and without miracles, is a compromise honestly offered by one who himself apparently still cherishes these beliefs. It is a fair attempt to arrive at some understanding by sinking out of sight the points upon which people differ, and by bringing into prominence their points of agreement.

As I suppose that most of my readers have either read this book or intend to do so, anything like a full account of its contents here will be unnecessary. It will not, however, be out of place to attempt a slight sketch of its general argument and conclusions. Our author begins by pointing to the divinity of nature as the common ground between Christianity and science. The real issue is not between theism and atheism, for science is in a very real sense a theology, and believers in nature have many of the feelings of Christians for their deity. Thus, we have a natural theology; it will widen into a natural religion, when the science of the relation of the universe to human ideals has grown up; and this science, upon a purely natural basis, is fast constructing itself. Defining worship as "habitual and permanent admiration," he sees nothing to fear in the gospels of art and humanity. Just as the gospel of science is an allotropic form of mediæval theology, so is the gospel of art the revival of Greek paganism under altered conditions, and the gospel of humanity that of Christianity. Each is, to some individuals, a faith in itself, because it lifts them above mere materialism, above conventionalism, above the ordinary run of men; in short, above what our author calls, boldly, atheism. "An atheist, in the proper sense of the word," he writes, "is not a man who disbelieves in the goodness of God, or in His distinctness from Nature, or in His personality. These disbeliefs may be as serious in their way as atheism, but they are different. Atheism is a disbelief in the *existence* of God—that is, a disbelief in *any* regularity in the Universe to which a man must conform himself under penalties." The religion of the future must combine all three worships. In the individual the results will be practically equivalent to culture, in the aggregate to civilization. The ideal of antiquity was one of separate nationalities, with separate religions; the ideal of the middle ages was an imperial state and a catholic church. The two ideals will be combined in the church and state of the future. The writer points out very clearly the connection between the spirit of nationality and the spirit of religion. The church of the future will be missionary, carrying its faith into uncivilized Asia and Africa; it will be undogmatic, it may even be without a temple, but it will not be without worship, for we have objects for this in nature on its various sides. He thus takes occasion to correct a very common misconception with regard to nature:

"It is often said that, when you substitute Nature for God, you take a thing heartless and pitiless instead of love and goodness. Undoubtedly much less of love and goodness can be discovered in Nature than Christians see in God. But when it is said that there are no such qualities in Nature, that Nature consists of relentless and ruthless laws, that Nature knows nothing of forgiveness, and inexorably exacts the utmost penalty for every transgression, a confusion is made between two different meanings which may be given to the word Nature. We are concerned here with Nature as opposed to that which is above Nature, not with Nature as opposed to man. We use it as a name comprehending all the uniform laws of the Universe as known in our experience, and excluding such laws as are inferred from experiences so exceptional and isolated as to be difficult of verification. In this sense Nature is not heartless or unrelenting; to say so would be equivalent to saying that pity and forgiveness are in all cases supernatural. It may be true that the law of gravitation is quite pitiless, that it will destroy the most innocent and amiable person with as little hesitation as the wrong-doer. But there are other laws which are not pitiless. There are laws under which human beings form themselves into communities, and set up courts in which the claims of individuals are weighed with careful skill. There are laws under which churches and philanthropical societies are formed, under which misery is sought out and relieved, and every evil that can be discovered in the world is redressed. Nature, in the sense in which we are now using the word, includes humanity, and therefore, so far from being pitiless, includes all the pity that belongs to the whole human family, and all the pity that they have accumulated and, as it were, capitalized in institutions, political, social, and ecclesiastical, through countless generations" (pp. 65, 66).

The writer thus looks upon natural theology as the "true deduction of the laws that govern the universe," as the "science of the relation of the universe to human ideals," and the following are some of the questions that it has to answer: "Is there a reward for virtue? Is there a compensation for undeserved misery? Is there a sure retribution for crime? . . . In one word, is life worth having, and the Universe a habitable place for one in whom the sense of duty has been awakened?" (p. 61). On the other hand, natural religion is "worship of whatever in the known Universe appears worthy of worship," it "is no mere dull morality, for in the first place it is far wider than any morality, being as wide as modern culture, and in the second place, so far as it is moral and bears fruit in morality, even here it is no mere morality, but an historic religion of humanity" (p. 172). It is "the principle by which alone life is redeemed from secularity and animalism." "Thus, instead of saying that the substance of religion is morality, and the effect of it moral goodness, we lay it down that the substance of religion is culture, and the fruit of it the higher life" (p. 138).

The strong point of such a system as this lies in its fully recognizing the facts of spiritual development that the review of the past thirty years reveals, viz.: that the religion of the churches is but one among other religions of the present day; that the work, heretofore done by religion, in raising the general tone of life, is now really being accomplished by the separate influences that are summed up in what we call *modern civilization*. But along with religion in the old sense went something more. Part of its charm lay in the light it threw on the darkness which encompassed men's lives. "So seems the life of man," said one of the early English converts to Christianity, "as a sparrow's flight through the hall when you are sitting at meat in winter-tide, with the warm fire lighted on the hearth, but the icy rainstorm without. The sparrow flies in at one door, and tarries for a moment in the light and heat of the hearth-fire, and then flying forth from the other vanishes into the wintry darkness whence it came. So tarries for a moment the life of man in our sight, but what is before it, what after it, we know not. If this new teaching tells us aught certainly of these, let us follow it." Thus religion acquired part of its hold on the minds of men by ministering to their growing desire for knowledge. But the completion of knowledge only leads to the realization of our own ignorance, and the gospel of science with regard to the Unknowable is but the echo of the words of Hooker, that "our soundest knowledge is to know that we know him not as indeed he is, neither can know him, and our safest eloquence concerning him is our silence."

The chief objection that any naturalistic scheme of religion has to encounter comes from those who, applying the language of jurisprudence to every-day life, urge that the three terms, *command*, *duty*, and *sanction*, are inseparably connected; that command and duty are correlative terms; that, wherever a duty lies, a command has been signified. Such arguers refuse to recognize in a religion without some supreme will constraining a religion at all. Thus Canon Liddon * calls religion "essentially a relation to a person. . . . Religion consists fundamentally in the practical recognition of a constraining bond between the inward life of man and an unseen Person; . . . the maintenance of a real relation with the personal God, or with a Divine Person really incarnate in Jesus Christ." The same objection appears in a slightly altered form in pages of the London "Spectator," in the course of a discussion upon natural religion, suggested by the work before us:

"We do not differ from this able writer in thinking that there is such a thing as 'natural religion,' but we do differ from him when he asserts there is such a thing for one who declines, or is unable, to discover in the universe traces of a superphysical, we would rather say, than a supernatural, Power—that is, traces of a power to mold and modify that in nature which is physical, in the direction and for the purposes of that in nature which is not physical, but mental and moral. There is no end of 'natural religion' in the mere discovery of human free-will, for that is the discovery that the adamantine chain of physical necessity has been and is interrupted by the will of man itself—a discovery utterly inconsistent with the favorite scientific view. There is no end of 'natural religion' in the discovery of conscience, that there is a moral obligation on us to do this rather than that—an obligation from which it is simply impossible to escape, without bringing on ourselves an unappeasable remorse, and a sense of conscious unworthiness from which it is impossible to dissociate the conviction of invisible condemnation and displeasure. There is no end of natural Christianity in the discovery that Christ is an ideal infinitely and hopelessly above and beyond us, and yet full of power to draw us upward, if we will, toward himself. But there is, to our minds, nothing worthy of the name of natural religion or natural Christianity at all that does not promise us guidance and excite in us trust. . . . The author of 'Ecce Homo' seems to us content to find a natural religion in that which is neither natural nor religious—not natural, because, in spite of the paradox, it is in the highest sense natural to man to lean on something beyond Nature; not religious, because religion means something which is binding, something which we can not in our hearts defy, and we can in our hearts defy any power which only threatens us with extinction, and does not threaten us with inextinguishable remorse."

* "Some Elements of Religion."

We may pass over the first objection to natural religion, viz., that it is not natural, because the argument appears a mere play upon words. Natural religion is called so because it differs from supernatural religion; because it is the religion that is deducible solely from the course of Nature, from the observance of the laws that govern the world in which we live. But it is also objected that the religion inculcated by civilization without supernaturalism is one that is *not binding*, one *which we can in our hearts defy*.

But are virtue, truth, and love less realities in life because we have dissociated from them the mythology in which they were originally bodied forth to the primitive mind—the clothes which were originally wrapped around them? Listen to the eloquent words of a recent writer: "We must *suffer* with Christ whether we *believe* in Him or not. We must suffer for the sin of others as for our own, and in this suffering we find a healing and purifying power and element. This is what gives to Christianity, in its simplest and most unlettered form, its force and life. Sin and suffering for sin; a sacrifice, itself mysterious, offered mysteriously to the Divine Nemesis, or Law of Sin—dread, undefined, unknown, yet sure and irresistible, with the iron necessity of law. . . . Virtue, truth, love, are not mere names; they stand for actual qualities which are well known and recognized among men. These qualities are the elements of an ideal life, of that absolute and perfect life of which our highest culture can catch but a glimpse. As Mr. Hobbes has traced the individual man up to the perfect state, or Civitas, let us work still lower, and trace the individual man from small origins to the position he at present fills. We shall find that he has attained any position of vantage he may occupy by following the laws which our instinct and conscience tell us are Divine." *

Yes! these laws are divine—not because we can see the legislator, not because they were supported in the past by supernaturalism; but because they rest upon our subjective consciousness, supported by science, by poetry, and the history of the life of man upon the earth; because they are vouched for by voices of the wise in all ages, and because they have become part of ourselves. And we have to obey these laws, not because we fear punishment in another world, but because the violation of them is followed by remorse and disaster in this; we have to do right, because it *is* right, because we can only attain the full perfection of our natures by doing so, because humanity will have it so. Mr. Mallock pointed out that, while science has reduced the earth to insignificance, has robbed it of its glory as the center of the universe, and man of his boasted eminence as the special pet of the Creator, still an intense self-consciousness has been developed in the modern world. "During the last few generations man has been curiously changing. Much of his old spontaneity of action has gone from him. He has become a creature looking before and

* "John Inglesant," chapters xxiii, xxxix.

after, and his native hue of resolution has been sicklied over by thought." True, and with this increase of self-consciousness have increased the binding force of the subjective feelings upon which right and wrong depend; we expect more of ourselves, and we expect more of our fellow-men. "Three hundred years before" (I am quoting again from Mr. Shorthouse), "in the child-like unconsciousness of spiritual conflict which the unquestioned rule of Rome for so long produced, it had been possible, in the days of Boccaccio, for cultivated and refined society to shut itself up in some earthly paradise, and, surrounded by horrors and by death, to spend its days in light wit and anecdote, undisturbed in mind, and kept in bodily health by cheerful enjoyment; but the time for such possibilities as these had long gone by." And if this was true of life in the seventeenth century, as compared with the fourteenth, with how much greater force does it apply to life in the nineteenth century!

I will approach the same subject from another point of view. It is possible to allow—in fact, it is impossible to deny—that conscience has not lost its force, notwithstanding the apparent weakening of the supernaturalism to which it has been usual to ascribe its origin and binding force. But the necessity of recognizing some supreme personal will is often urged as a mental necessity, at least as a convenient theory. If the Supreme Being did not exist, it would be necessary to invent him. We can often see our own fallacies in a clearer light by comparing them with modes of thought in the past, now recognized to be no longer sound. And this struck me very forcibly the other day when I was reading Dante's pleading for the maintenance of the supreme power of the emperor in the middle ages. These arguments, I thought, in the "De Monarchia," are exactly the arguments we hear urged every day in favor of the existence of a personal will in the government of the universe. Yet it may be possible that, as society has managed to exist and to improve without the existence of the former, so our moral and religious life will continue practically unaltered without the conscious recognition of the latter. I will illustrate by extracts.

Dante points out what may be called the physical necessity for a single monarch: "Since the whole heaven is regulated with one motion, to wit, that of the *primum mobile*, and by one mover, who is God, in all its parts, movements, and movers (and this human reason readily seizes from science); therefore, if our argument be correct, the human race is at its best state when, both in its movements and in regard to those who move it, it is regulated by a single Prince, as by the single movement of heaven, and by one law, as by a single motion. Therefore, it is evidently necessary for the welfare of the world for there to be a Monarchy, a single Princedom, which men call the Empire." *

* "De Monarchia," Book I, chap. ix.

In the same manner he shows that justice and order depend upon the stability of the imperial power: "Justice is strongest in the world when it is in one who is most willing and most powerful; only the Monarch is this; therefore, only when Justice is in the Monarch is it strongest in the world. . . . All concord depends on unity which is in wills; the human race, when it is at its best, is a kind of concord; for as one man at his best is a kind of concord, and as the like is true of the family, the city, and the kingdom; so is it of the whole human race. Therefore, the human race at its best depends on the unity which is in will. But this can not be unless there be one will to be the single mistress and regulating influence of all the rest. And this can not be unless there is one prince over all, whose will shall be the mistress and regulating influence of all the others. But if all these conclusions be true, as they are, it is necessary for the highest welfare of the human race that there should be a Monarch in the world; and, therefore, Monarchy is necessary for the good of the world."*

It is curious to remark that for a moment Dante seems to have caught sight of the modern point of view in regard to supreme power in the political and religious world. He is arguing against the mediæval symbolism which saw in the sun and moon the types of the two great powers on earth: "Seeing that *these two kinds of power are, in a sense, accidents of men, God would thus appear to have used a perverted order, by producing the accidents before the essence to which they belong existed.*" In the same way we should argue, extending the terms, that before the essential point of government in the political and religious world, viz., order and morality, became distinctly conscious in the minds of men, their accidents, the divine state and the divine Church, came into being. This view, however, he summarily rejects: "It is ridiculous to say this of God. For the two great lights were created on the fourth day, while man was not created till the sixth day, as is evident in the text of Scripture." †

The real secret of the persistence of the supernatural in an age of science is the tacit allowance that "what can not be demonstrated by observation not to exist may be taken as existing for purposes of edification." ‡ For many years to come we shall probably continue to meet in the same communities with what would at first appear to be strange inconsistencies. Thus, at the end of August, Montreal was welcoming with open arms the high-priests of the new faith, the leaders of the American scientific world. Little more than a fortnight afterward, they were expressing their devout gratitude to the Giver of all good for enabling British soldiers to crush the wretched Egyptian, and add to the luster and renown of British arms.# And to those who

* "De Monarchia," Book I, chaps. xi–xv. † Ibid., Book III, chap. iv.

‡ Leslie Stephen.

\# On September 16th a resolution was passed by a public meeting of the citizens of Montreal, expressing "devoted loyalty to her Majesty's crown and Government," and have faith in the future of humanity, in the eventual evolution of a verifiable and complete science of life, such a mixture of the strands of religious consciousness will cause no uneasiness. For just as the earliest scientific psychology cheerfully recognized the two sides of the human mind—the rational and the irrational—as equally necessary, equally human, so in an altered sense we may say that the religion of humanity, as it springs from the human heart, must not only take cognizance of its justifiable aspirations, but of those hopes and fears also which in a strict sense of the word we might be tempted to call irrational, as in no sense founded on reason, if not in direct antagonism with it. Yet, we are not, for all that, obliged to postulate an essence above and beyond human reason, as the cause of these emotions and sentiments. Rather, they are the gropings of the human spirit in its efforts—efforts ever to be renewed and ever baffled—to comprehend the Unknowable. "Poor men, most admirable, most pitiable," cries "A Voice from the Nile"—

> ". . . man
> Has fear and hope and fantasy and awe
> And wistful yearnings and unsated loves
> That strain beyond the limits of his life,
> And therefore Gods and Demons, Heaven and Hell;
> This Man, the admirable, the pitiable."

And therefore, we may add, recognizing the fact as fully as the adherents of the old faith, therefore does man differ from the other animals. But none the less are we bound to recognize also that in this special sphere, in religion, whose function it was to raise men above themselves by raising their thoughts to something higher than themselves, the center of gravity, so to speak, has changed. To the ancient mind, the highest truth lay in the region of idea; to the modern mind, in the world of fact. The religion of men in the middle ages was their poetry, their science, their consolation for the ills of life; it made mankind better, but did not consciously aim at making the world a better place to dwell in; their eyes were turned to a resting-place above, for which life on earth was at best a school of discipline. The supposition upon which these beliefs rested, "that our living nature will *continue* after death," * we can rest upon with confidence no longer—it is at best but an aspiration; and our religion is nothing if it does not aim at the improvement of the world in which we live, if it does not ground itself upon a basis of fact. Yet, even so, the best advice is probably that of the great master of human wisdom, who,

resolving that "we express our devout gratitude to Almighty God, the Giver of all good, for the brilliant successes granted to the British arms in Egypt; that we rejoice that our forces have by their courage and devotion added to the luster and renown which British valor has achieved in all quarters of the globe." The resolutions "were all carried unanimously, amid enthusiastic cheering."

* Butler's "Analogy," conclusion to Part I.

living long years ago before the hubbub of Christian and anti-Christian controversy, exhorted us not to follow the advice of those who bid us tame down our aspirations to our mortal condition, but as far as possible to think the thoughts of immortals, and to live in our every act up to the noblest part within us.*

VIVISECTION AND PRACTICAL MEDICINE.

By G. F. YEO, F. R. C. S.,
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OVER and over again we have been challenged by the opponents of science to give "one conclusive example where experiment has been of direct use to practical medicine." To any one familiar with the history of scientific medicine there can be no difficulty in finding numerous such instances, and, as a matter of fact, many examples have from time to time been given by various writers; but to make these cases satisfactory and conclusive to persons who know but little, and do not care to know more, of the true bearings of the question, is a very difficult matter. Such a test is totally wrong and misleading when applied to the utility of experiment on the lower animals. The matter must be viewed from a wider stand-point than that embracing only single instances of direct benefits accruing from specific experiments.

The primary object of experimental research is to advance physiology—the science which teaches us the uses of the various organs and textures of the body in the normal state, and how the working of the animal economy is carried on in health. The value of physiology depends on the knowledge it gives us of the normal operations of the body, and not on the few cases in which certain experiments happen to aid us in understanding disease, and thus directly promote the practice of the healing art. Our argument is rather this: Physiology is the foundation of both pathology and therapeutics, which together make up medicine; and therefore rational medicine depends directly upon physiology for its strong growth and genuine progress.

Now, physiology can not advance without vivisection; experiment on living animals is as essential to its progress (though far less general in application) as is dissection for the study of anatomy. Therefore, experimental research, including that carried out on living animals, is as necessary for the progress of the practice of medicine as is experimental research in any other science for its advancement and application to daily life. The immediate object of physiological experiment is, then, not to make out new practical methods of treating dis-

* Aristotle's "Nic. Ethics," Book X, chap. vii, § 8.

ease, but rather to attain to a more complete and sound understanding of those general laws which govern the actions of the living body in health—laws which must ever form the only firm basis of the knowledge of disease, and the only sure guide to judicious modes of treatment.

The rational practice of physic, as it is carried on in the present day, is in a great measure the outgrowth of a slowly growing physiological science, upon which it depends, and from which it can not be separated. There is hardly a thought that can strike a practitioner that does not in some way depend upon physiological facts which have been elicited by experimental research. I do not mean to state that the accurate and painstaking observation of clinical facts and *post-mortem* appearances has not done much—probably more than anything else—to bring our medical knowledge to its present stand-point; but I contend that clinical observation and *post-mortem* experience without physiological research would never have been able to advance medicine to the position it holds in modern times; and, on the other hand, I believe that physiological study, even unaided, could arrive at a rational system of treatment. No doubt both clinical study and pathological observation have not only helped practical medicine onward, but they have also greatly contributed to the progress of physiology itself. In fact, I find it impossible to separate exact clinical and pathological work from scientific research of a purely physiological nature. Is not all treatment more or less experiment? And is not this particularly true of purely empirical treatment? Nowadays, where is the pathological laboratory in which a mere record of *post-mortem* changes in the human subject is not aided by experimental inquiry into pathological changes in the lower animals?

In assigning to each department of medical study its due meed of credit, their relative ages must be borne in mind. It has been asserted that all the improvements brought about by experimental research would have been introduced with equal certainty had experiment on living animals never been attempted. Observation, experience, and thought would have attained all the results we now enjoy. Possibly so; but when? Clinical observation can be traced back some three or four thousand years, and even then it started with a rich legacy of traditional knowledge. Experimental physiology as a science was only born about a hundred years ago. If we compare the progress made by medicine during the last hundred years with that of the previous thousand years, we shall be able to judge of the relative rates of progress of the two systems of working. The difference seems to me to lie in the fact that unaided clinical observation—that is, practically the empiric method—goes the wrong way about arriving at a conclusion. It says, Try this or that or the other remedy, and note which is successful. This is like a boy who will not systematically work out his sum in long division, but prefers to arrive at the quotient by guessing probable numbers one after the other, and multiplies them to see which is the right one; he may, after much trouble, by chance hit upon the correct answer, but he more commonly fails: and most probably the boy who works out his sum in the straightforward way will far sooner arrive at the desired result. Physiology moves onward by means of accumulating and arranging facts which have borne the test of experiment. Empiricism accumulates observations which, without further test, are used to formulate theories that, as likely as not, are unfounded, and are as apt to mislead as to advance medical knowledge. When asked to give an example of the utility of experimental physiology in the treatment of disease, I feel inclined to answer with another question: Is there one reliable system of diagnosis or one mode of treatment now in use which has not been modified or improved, if not directly suggested, by physiological knowledge? And I must certainly confess that I know none. Before attempting to bring forward single cases, as instances where certain experiments have been of direct use to medical and surgical practice, I shall examine the question from the opposite stand-point, by taking some simple case of every-day occurrence, and glancing at its routine examination and treatment. We can then see to what extent vivisection influences the practitioner in the details of his daily work. We may safely take a case at random; one not associated very closely in our minds with any brilliant experimentation will, perhaps, be the best. The following case, which I happen to have seen recently, will do as well as any other:

Not long since I found a policeman examining a poor woman who was said to have had a "stroke." She lay speechless and motionless on a door-step; she showed no signs of convulsions, no stertorous breathing, no frothing at the mouth. So the policeman hesitated to make a diagnosis—thinking, no doubt, that other causes besides a "stroke" might give rise to such a want of muscular irritability. Gently shaking her had no effect, but on his applying some form of stimulus to the finger she showed signs of returning consciousness, and the *left* leg and arm moved slightly. The right eye remained partly open, the other was closed; when the eyelid was raised, so as to expose the pupil to the sunshine, some movement of the muscles of expression was observable, but only on the left half of the face, to which side the mouth was slightly drawn. This became more obvious when some drops of cold water were thrown at her. The pulsation of the temporal artery was visible. Putting my ear to the top of her chest I found the heart beating violently, and heard a prolonged blowing noise instead of the sharp, clear tone of the second heart-sound. Without much effort my thoughts had passed from the pulsating temporal artery to the heart, and from the imperfect aortic valves to the middle cerebral artery, where I fancied an embolus must be impacted. I told the policeman the woman had better be taken to a hospital, which was done accordingly.

How was it that I was able confidently to advise the policeman about this poor woman, though he was no doubt very experienced in this sort of cases? What aid did experimental inquiry give me in arriving at my conclusion?

Well, in the first place, I knew that the paralysis was restricted to voluntary movements, without the motions belonging to organic life being in the least interfered with. Vivisections of the earliest times informed me that this was quite possible as a result of some injury of the nerve-centers, and experiments of more recent date enabled me to exclude a large part of these centers from being the seat of the lesion. That there was no local injury of the spinal cord in the dorsal region I knew, both from the loss of consciousness and from the fact that the reflex action of the lower limbs was not intensified, and vivisections informed me they would have become so had this been the case. I could see by the movement of the left leg that only one side of the body was paralyzed; and then the look of the face distinctly showed that part of the seventh cranial nerve, which Charles Bell's vivisections taught me to know to be motor in function, was paralyzed. This fact, together with the ready reflex action of the eyes and the sound side of the face, which I knew by vivisection required unimpaired sensory nerves, showed me that it could not be a case of profound toxæmia such as the policeman supposed to be possible. I knew by vivisections performed by many English physicians and physiologists, some of whom are still among us, that the second heart-sound depended on a certain action of the aortic valves. Not hearing the familiar sound, I concluded that the aortic valves must be diseased. Experiments on living animals concerning coagulation of the blood within the vessels informed me that when the lining coat of a blood-vessel, or the heart, is diseased, little clots are often formed at the diseased or injured part. I knew, further, from Virchow's classical experiments on living animals, that emboli introduced into the arterial blood-current often become impacted in the middle cerebral artery, and that the embolic blocking of a brain-artery, by shutting off the blood from the area it supplied, caused a sudden arrest of function of the part. Although the nerves going to the various paralyzed muscles arose from very different regions of the cord and brain, I know by vivisections that there is a part of the cortex of the brain the injury of which would cause them all to be powerless. Clinical observation and pathological anatomy would have informed me that it was probably a brain-lesion; but, had it not been for the light thrown by vivisection on the few facts I was able thus hurriedly to observe, I should not have been much wiser than any other by-stander, and could only have agreed with them that it was a "stroke" of paralysis.

Now let us consider a surgical case. The other day I mentioned some of the old methods of operation, when buttons of vitriol, caustics, steel compresses, boiling oil, hot irons, a copious receptacle for catching the blood, and elaborate machines, such as those on the table, were among the apparatus the surgeon had to prepare for operation.

Let us now turn to a modern operation, and let us consider whether our present *modus operandi* is influenced by the light which experimental inquiry has shed on physiology during the last century. I shall not attempt to recount any one of the numerous cases which the surgeon now approaches with perfect confidence of undoubted success, although a comparatively short time back they would have been looked upon as completely beyond his reach. Many such cases, which formerly would have led either to certain death, enduring misery, or life-long inconvenience, must occur to the minds of all here. Let us take a case of disease or injury requiring the amputation of a portion of an extremity. In the first place the patient is made quite insensible to pain by the administration of chloroform, or some such drug; not only is he insensible to pain, but also unconscious to all that he formerly would have been obliged to see and hear, by no means the least painful part of the operation. With regard to the use of anæsthetics, I shall not delay, for vivisection can not claim to be the sole means of introducing this great boon to modern surgery, although experiment on living animals played a most prominent part both in their discovery and their introduction into common use in this country, as has been frequently pointed out.

The next step in the operation is to make the part bloodless. This can be done in the following way: By holding up the limb for some time to facilitate the flow of blood from the veins, and thus to reduce the blood-pressure within these vessels, by which means the local vasomotor mechanisms are brought into play with considerable force, so as to reduce the quantity of blood in the limb, allowing only a limited flow to continue. Then Esmarch's elastic bandage may be applied to further empty the minute blood-vessels. By this means the textures to be cut into may be made to remain, during the active part of the operation, as bloodless as those of a corpse. The advantage of having no dread of hæmorrhage to induce haste, no blood to impede the view, or render the instruments difficult to handle, can hardly be overestimated. So that, even apart from the all-important point of preventing the weakly patient losing blood, this bloodless surgery must be regarded as one of the most important improvements in modern methods. And how far may it be traced to vivisection? We know that the contractility of the blood-vessels, and the high pressure of the blood in the arteries, as well as the motions of the heart and the course of the blood, were demonstrated by this means; and is not this the key of the whole matter? But, further, were we not familiar by vivisections, and by the removal of tissues from the bodies of recently killed animals, with the fact that the textures can retain their life and function for a considerable period after their normal circulation has ceased, who would have dared to suggest that the entire limb of a living man should be deprived of its blood during the time occupied by a tedious operation?

Then, with regard to the means of permanently arresting the escape of blood from the wounded vessels. We have no longer a receptacle for blood; indeed, the handful of sawdust on the floor that was fashionable when I began medicine is no longer used. John Bell, after giving a graphic and fearful account of the terrors of hæmorrhage, says: "Is not this fear of hæmorrhagy always uppermost in the mind of the young surgeon? Were this one danger removed, would he not go forward in his profession almost without fear?" I do not think this fear ever crosses the mind of the young surgeon now, so rare are deaths from external hæmorrhage. I have never seen one death from such loss of blood in the twenty years that have passed since I first commenced to study medicine. Why has the dread of bleeding ceased to chill the heart of the surgeon when entering on an operation? Vivisection has not done all, but it has done much to help us to attain to this degree of excellence in our present methods.

The use of the ligature can be traced so far back in the history of medicine that it is impossible to say whether it was first used upon man or animals. Very definite accounts of it occur in the writings of the Arabians of the tenth or twelfth century. Although its value, or rather its great convenience, in military surgery was recognized and extolled by Ambroise Paré, the inestimable value of the ligature remained unknown in general practice for nearly a hundred years after his time. This was, no doubt, partly on account of the fact that experiment was not used to test its efficacy and mode of action until comparatively recently. By vivisections the chief errors in its application were by slow degrees removed, and now we rest almost exclusively on the improved method of tying arteries as the means of arresting the flow of blood from a recent wound. First of all, the nerves used to be included in the ligature. Vivisection showed the folly of thus attempting to confine the animal spirits, or nervous fluid, and practice proved that thus tying the nerves always caused excruciating agony, and often gave rise to fatal spasms (tetanus), which made ligature to be dreaded even by its warmest advocates. In the second place, the wide ligatures which were made of soft material and lightly tied over corks, etc., often failed to check the bleeding. Dr. John Thomson, of Edinburgh, was among the first who made experiments on this subject, and I believe much of the credit given to Jones really belongs to him. Following the precepts taught by Thomson, Jones also made numerous experiments on animals. He found that a hard, thin ligature, applied so as to cut the elastic inner coats and leave the tough outer wall of the vessel uninjured, was much more surely followed by a deposit of "coagulable lymph," and by more satisfactory occlusion of the vessel, than when one or several soft bands were tied lightly on it. This fact hardly gained the universal and complete confidence of surgeons until further vivisections performed by Lister, Brücke, and others, showed that the smooth lining of the vessel was the chief factor in preventing coagulation, and that intravascular clots are formed most readily when the lining of the vessel was injured and the blood ceased to move. Instead of timidly tying a loose knot for fear of injuring the vessel, the surgeon now ties a firm ligature so as to rupture its lining coat, or at least to apply sufficient pressure to cut off its nutrition and thus cause its death in order to make a starting-point for the coagulation which must occur to secure its permanent closure.

Another great objection to the old ligatures was the delay they caused in coming away. This wearied the surgeon and exhausted the patient. The ligature was sometimes pulled away before its time, and this often gave rise to the much-dreaded secondary hæmorrhage. In counseling that the ligature be left alone, Petit adds the remark, as a kind of consolation, that he finds them generally to come away of themselves in about two or three months. Of this sort of annoyance we hear nothing now. Experiment on the lower animals has taught us the existence of the lymphatics and their absorbing power. Experiments upon living animals has shown us that this power of absorbing extends to such things as catgut, a material readily made into strong cords. Properly prepared catgut is, therefore, almost universally used as a ligature, the ends are cut off short, and the knot is left to be absorbed, and never once thought of again.

And, lastly, the edges of the wound are brought together with stitches of silver wire, silk, catgut, horse-hair, according to whether much or little traction or more or less coaptation is demanded. Undue tension, compression, gaping, and irregularity of the wounded part, are all avoided ; a means of exit for serous oozing, etc., is provided by non-irritating drainage-tubes. The antiseptic dressings are applied carefully and exactly. Large tents, dossils of lint, rude compresses are not thought of. The aseptic wound heals without swelling or inflammation. No throb disturbs the patient's rest. No drop of pus comes from the cut surface. Fever, tetanus, pyæmia, second hæmorahage, as well as the old dread of the bleeding during the operation, are all nearly forgotten.

To the minds of the surgeons of the last century such a method of operation and such a mode of healing would probably suggest the longed-for magic remedies by means of which many hoped to replace the cauteries, caustics, compresses, and filthy dressings with which they strove to heal the open wounds of their exhausted and cachectic patients.—*Lancet.*

EVOLUTION OF THE CAMP-MEETING.

By JOSEPH PARRISH, M. D.

HALF a century ago, camp-meetings were chiefly the outgrowth of Methodist zeal and enthusiasm. They were a sort of religious holiday, when good men and women who were loyal to their convictions, and earnest to disseminate the truth as they understood and believed it, came from far and near, in sparsely settled regions of country, to kindle afresh in the hearts of each other the fervor and inspiration of their peculiar dogmas and methods.

Ox-teams and hay-wagons, the old-fashioned chaise and chair, the side-saddle and cart, were among the means employed to reach the place of meeting. Many also went on foot, making a long and weary pilgrimage. Congregations joined each other, employed their own means of transportation, carrying their own society tent and commissariat; and thus thousands came together with but one single object in view, which was, in the language of their distinguished founder, "to spread holiness throughout these lands." Their greatest preachers were called to join and help them; and, with characteristic fidelity, and sacrifice of personal ease, ecclesiastics of highest renown joined in the simplest and rudest methods of tent-life, and labored with power and efficiency to bring the thoughtless and wandering to a better and a higher life.

The preaching was simple, direct, and powerful, and the result was, large accessions to the church. A camp-meeting was a sort of religious harvest-home, an in-gathering of fruit from seed that had been sown during the year, in local churches, as well as from the direct influence of the special services. In addition to this, old fellowships were renewed and fraternal interests and greetings were revived, and, at its close, thousands of the faithful scattered to their homes again, with renewed assurances that camp-meeting work was a blessing to themselves and to others. Such was the old-time line of thought and expression. But now, times have changed. Population has increased rapidly, facilities for travel have multiplied, the desert and wilderness have been penetrated by railroads, and the adventurous frontiersman is not without numerous companionships.

Towns and churches have grown up, as the migrating crowds have moved on in one continuous caravan, until the mountains, and the Pacific slope beyond them, are already occupied; and we find prosperous settlements of miners, farmers, and adventurers of all kinds and grades, dwelling in the midst of each other. The fathers in the olden time would have looked to the West, with its moving multitudes, and planted their tents to capture them; but modern Methodism plants the churches as the people settle, and, to preserve the camp-meeting feature of the denomination, they seek fields already populated and locate themselves in more profitable places. Where are these places? The answer to this question discloses a phenomenal fact, that, could it be announced to them, would bring the scarlet to the cheek of Wesley, and bow the heads of Asbury and Whitefield with confusion of face.

The camp-meeting of to-day is a very different affair. It is not an extemporaneous festival in which the membership of one or more churches take the lead, select a place of meeting, and invite neighboring churches to participate in a common service, each bearing its share of the burden, and then scatter to their homes, to disband and be as if they had not been. No, it is a very different thing. It is the fruit of a chartered association, with corporate rights and franchises, of the same nature as those which belong to banking and railroad associations. Of course, the corporators are religious men, and the controlling influence is secured to the ministry. A copy of such a charter is now before me. It gives the institution its corporate name, and states its object to be "the establishment and maintenance of a sea-side resort, founded upon Christian principles, and affording religious privileges as well as healthful recreation."

Provision is made for the transfer and redemption of stock, for voting by shares and by proxy, as is usual in other money-making companies. It defines the number of directors, one third of whom shall be ministers, and one other third shall be ministers and members of the Methodist Episcopal Church. Its president "*shall* be a regularly ordained minister of the Methodist Episcopal Church, having control of the conventions, assemblies, and other meetings that may, from time to time, be held on the premises; and the secretary and treasurer must give bonds for the faithful performance of their duty—in one instance, as high as thirty thousand dollars. Is not this an anomaly? The camp-meeting feature, if indeed it is prominent enough to be a feature, is merely incidental to the main object, viz., the establishment of a sea-side resort. To do this, land must be purchased, stock must be sold to pay for it, and the pastor-president is to be the executive officer through whom these conveyances are to be made, and by whom all the real-estate transactions are to be ratified. The entire time, out of the three hundred working days of the year, that is to be set aside for camp-meeting services, is ten days or a fortnight, and the remainder is occupied with the secular business of the concern. We are largely indebted to these associations for the grand development they have made, on the New Jersey coast especially. Witness Ocean Grove, Ocean City, and Atlantic Highlands. They have taken up coast-lands, some of which were comparatively worthless, and made them into fruitful towns, with prosperous and happy peoples. They are to be credited also with the testimony they have borne to sobriety and good morals, by preventing the sale of intoxicating liquors within their boundaries; but it is a question for them to consider, whether the cause of Christianity has been actually benefited by their policy. It is a question whether the *sample* preaching of the present camp-meeting style is as effectual as were the direct and incisive appeals of those whose voices are now hushed in the grave. Is it not more after the manner of "trial-efforts"? Which can do the best? Who can make the best impression? It may be ornate, picturesque, and beautiful. It may captivate the senses and satisfy the taste of the hearers; but does it meet the needs of the multitudes who come to hear?

Again, are immense crowds of people wholesome? Are there always vigor and force and efficiency in numbers, unless there is exact unity?

In such promiscuous multitudes as crowd the cottages and the strand, and as go in and out of tents and barracks, coming as they do from all parts, and representing as they do various grades of social life, there must be forces and influences that are constantly at work, and whether their influence is toward the better or worse side of human nature it is hard to say. They are not all Christian professors, and they are all human. They are loosed from the restraints of home, and are on a vacation for pleasure. They are crowded together, and, in order to be physically healthy and morally pure, their environment must do much to assist them. In this regard their relation to space and surroundings should be, if possible, essentially promotive of such conditions. How is it? In the number of cottages and tents, especially those appropriated to cheap boarding, we venture to say that there are more people lodged and fed than can be found in any equal number of dwellings in any other city or community of an equal population of well-to-do people. This is of itself demoralizing. It is out of harmony with the spirit of the age, which demands freedom and space, in proportion to population, in a ratio that is overlooked or disregarded at such sea-side resorts. There is, however, one conservative and redeeming fact in connection with this practice of promiscuous crowding, and that is, that the season is short and the people live most of the time out-of-doors. The time is at hand, however, when there will be a change. It will not be tolerated by a sanitary-wise people that there shall continue an unwholesome contact of dwellings, with cess-pools and water-wells within stepping-distance of each other and from the kitchen-doors. Nor should buildings continue to be so contiguous that one may walk from roof to roof, under which people live in contracted apartments, separated by thin board partitions, which, even for purposes of common privacy and propriety, are scarcely sufficient. It is true, and justice demands its utterance, that later improvements have, to a good extent, avoided these evils, and that the class of private homes and boarding-houses now being built are more in accord with a civilization that, at a Christian resort especially, should be conspicuous.

The great end of these corporations is to establish and maintain sea-side resorts; that is to say, to sell and lease lots and to build houses. To provide a market and secure competition, conventions of various kinds meet at these ample grounds, occupy the commodious buildings, and transact their legitimate business. It is all done in the name of religion, and may or may not be in fact and in spirit harmonious with the most exalted standard of Christian methods, according to the outlook from which the subject is viewed. If we take Ocean Grove as the type of such places, it is not, after all, so great a marvel that it has grown from a desolate sand-bank to a beautiful city within the last twelve years, when we consider the whole case. With missionary conventions, Sunday-school anniversaries, temperance assemblies, and camp-meetings, drawing upon an immense constituency in all parts of the country, and bringing thousands of visitors to the spot, with fair opportunities for investing money with a good hope of speedy return, it is not surprising that investments were made. Then, every laudable thing was done to rekindle and keep alive denominational pride and loyalty. The lakes that bound the Grove on the north and south are named for Wesley and Fletcher, while the avenues and parks are known by the names of departed worthies, whose memory is revered by the Church; and then, to complete the programme of attractions, the annual camp-meeting, occurring in the height of the holiday season, is made the central, the pivotal figure around which all the others are grouped. It has been a success as a venture to establish a sea-side resort; whether it has been a success as a means of intensifying and purifying the religious life of the people is as yet a problem without a solution. The time is past when even the common mind measures the depth of human character, and gives it credit or not for truth and righteousness, by the amount of religious fervor or the degree of religious profession it may exhibit. To be acceptable to common sense, and appreciated by right-minded people, the manhood must show itself moved to all good activities by a force from within that is invincible—a force, in itself silent and unobserved, but in its effect on character demonstrative in a life of goodness.

SEWAGE AT THE SEA-SIDE.

By ALICE HYNEMAN RHINE.

AMONG the thousands who go to the sea-side for health and pleasure, few pay any attention to the hygienic conditions under which they are to live for three of the most trying months in the year. The furniture of parlors and size of dancing-rooms and amusement-halls are taken into consideration, instead of finding out how sewage is disposed of and what relations cess-pool drains are having with the wells. Land-owners and hotel-keepers, following the drift of fashion, furnish what their patrons desire, neither side caring apparently how close a connection is established between animal excreta and the food which is eaten, the water which is drunk, and the air which is breathed.

Nor is this carelessness confined to places merely fashionable. In Ocean Grove, a religious resort, no attempt has yet been made to remove fecal accumulations by means of sewerage, or to substitute cleanly earth-closets for the disgusting cess-pool and privy. Hence the wells are polluted by human excreta, and the air smells vilely, particularly during the period of the great open-air camp-meetings.

At these gatherings over twenty thousand people assemble, who congregate together in a comparatively small space. The greater part of this multitude dwell in long lines of camp-tents, closely huddled together, and pay but little regard to hygienic methods. The executive committee of the association owning the place is equally neglectful, as they have made totally inadequate provision for carrying away the excreted material of so many people.

For the purpose of insuring better sanitary conditions than those prevailing elsewhere on the Jersey coast, Asbury Park was sewered, during the winter and spring of 1882, with eleven miles of clay pipes. Unfortunately for the traveling public, this sewerage system was a failure. Constructed in the slap-dash manner that prevails over the country generally, its working illustrated the fact that an imperfect sewer for sewage is worse than no sewer at all.

Why this system should not work well is easily understood by looking at the flat dead level of the Atlantic coast at this point, and learning that, to assist the discharge of sewage-matter into the ocean, the sewers have scarcely a fall of one inch in many hundred feet. Their outlets are built but little above low-water mark; consequently, when they get clogged by the tide, which they do except at low water, their gaseous contents are turned back over the land, to deal out disease and death in as many ways as Panurge had of making money.

Again, the principal outlet of the sewers empties immediately in front of and at the foot of the main street; effluvia from this, during the months of July and August, were emitted in morbific quantities; and, although natural causes prevented any outbreak of virulent types of disease, physicians were kept busy attending cases of fever, cramps, and dysentery. While it is admitted that this sewage-stench *per se* might not have been the cause of these disorders, yet there is strong probability of it, when it is considered that the sewage of Glasgow, although conveyed in barges over twenty-five miles, to a deep and wide loch out in the country, engendered new types of disease, and converted one of the healthiest sea-side resorts into a pestilential fever-center.

Some attempt at remedying this condition in Asbury was made by erecting ventilators, consisting of vertical wooden pipes, about twelve feet in height. These chimneys, placed upon sites chosen apparently without any attention to vertical or horizontal curves in the system, gave forth such fearful smells that at times the beach in their vicinity was unendurable. One near the principal promenade was abolished upon the insistance of hotel proprietors.

This failure added one more to the list of futile experiments which have been made with tall chimneys, having for their purpose the creation of a strong draught from the sewer. Tried in England, they are said never to have worked satisfactorily.

The placing such ventilators, as well as sewers, in a sandy soil, is always a hazardous experiment. If the principal streets are unpaved, surface-sand is liable to fill the sewer and choke it. And paving will not prevent silting up where there is an insufficient fall to allow hydrostatic pressure to force out incoming waves and tides. When egress of sewer-contents is thus checked, "*cela va sans dire*," the air is filled with a most disgusting stench.

Unhealthy as this contaminated air is, sea-side visitors incur a more common danger in the pollution of water by sewage. This poisoning is done in many ways—by close proximity of wells to sewer-drains, and by flood-water from rain-storms, which, instead of being utilized, is allowed to flow off along the gutters, sidewalks, and roadways. Across level lands, down through porous sand, this water sinks unchecked into the soil, carrying with it all the filth washed from streets teeming with human life during the hottest months of the year.

Civilization's barbarism makes this the more dangerous through the custom of crowding pig-sties, cow and stable yards, cess-pools, and all dirt-receptacles close to springs, wells, and other sources of drinking-water.

Little or no attention is paid to this dirty practice, on account of the popular belief that filtration through the sand purifies water of the poisonous principles contained in sewage-matter. This idea has been disproved by experiments of the United States Geological Survey in 1881. Results were then ascertained which showed very clearly that sand interposes absolutely no barrier between wells and the bacterial infection from cess-pools and privies lying even at great distances in the lower wet stratum of sand. Professor R. Pumpelly, who conducted the survey, says that filtration of sewage-water, through a great many feet even of sand as well as gravel, fails to free it of its organic impurities and the germs of disease.

In consequence of general ignorance of this fact, even when water is sufficiently impregnated with impurities to have acquired a foul taste, the mass of people will drink it without observation; or only notice it so far as to remark that "good water is never found at the sea-side." The majority drank without hesitation at Long Branch, or simply adulterated the water with wine or brandy, even after investigation had shown that the feeding-springs from which the water supply was drawn were contaminated by soakage from hog-pens and other animal refuse which had been allowed to percolate the soil unchecked.

The careless drinking of water so poisoned was the cause of an outbreak of typhoid fever during the past season at Seabright, a village adjacent to Long Branch, and supplied with water from the same source. Red Bank and Atlantic City were simultaneously afflicted with zymotic and malarial fevers through a similar cause; while Newport, heretofore considered a healthy sea-side resort, had a case of Asiatic cholera, and diarrhœa was almost epidemic. These conditions resulted from imperfect sewer-traps, by which almost every well and cellar in Newport was contaminated, unclean streets, filthy with the dirt of numerous horses, and sewers in a state the worst that could possibly be imagined.

From such causes as these an unusual amount of sickness prevailed during the past season along the whole line of the Atlantic sea-coast.

In these sporadic cases Nature sounded that key-note of warning with which she always precedes an epidemic. If unheeded, another season may witness the usual calamitous results that have invariably occurred before man has been taught that saddest and most difficult of hygienic lessons—how to protect life from filth-diseases.

This problem has been solved in great measure for the hamlet by almost all large cities. Wherever men have congregated in great numbers, plagues have occurred until they have learned to be careful of the disposition of their sewage. Memphis, which is one of the latest instances, after being terribly scourged by yellow fever in 1878, and again in 1879, took the precaution to immediately institute sanitary reforms, which have been followed by the best practical results. The leading features in these improvements were: the cleansing of the city of all objectionable accumulations, the abolition of all privy-vaults, cess-pools, and improperly constructed underground and surface drains, and the substitution of a complete system of sewers and subsoil drainage-pipes. The water-supply was improved, and the streets properly paved.

What has been accomplished by these measures for the proper sanitation of Memphis and other business centers is what remains to be done for the health and comfort of sea-side towns and villages along the Atlantic coast.

ICEBERGS AND FOG IN THE NORTH ATLANTIC.

By Captain J. W. SHACKFORD.

DURING the season of 1882 the ice and fog in the track of steamers running between Europe and North America appear to have attracted much more attention than heretofore, not only in consequence of the unusual quantities of field-ice and bergs reported, but also because of the increase in the traffic, and in the number of passengers transported.

Every one who has sailed for any number of passages on the western route *via* 43° latitude and 50° longitude—the track usually followed in ice-months—must have often experienced the sudden change from a dense fog to fine, clear weather, and sometimes to an almost cloudless sky. This change occurs most frequently to the westward of the Grand Bank, and with the wind to the south of west; the clearing which follows a northerly wind taking place more slowly. This sudden lifting of the fog is nearly always due to a change in the temperature of the surface-water. In sailing from the 43d to the 41st parallel, between the Grand Bank and George's, I have occasionally known the fog to clear and shut down again many times during the twenty-four hours; and almost invariably, upon trying the surface-water, found that while the weather continued clear the surface-temperature rose to between 55° and 65° Fahr., and, upon the temperature of the water falling below 55° Fahr., the fog again closed in; to be again followed by clearer weather as the ship sailed into warmer water—thus alternating from a dense fog to a clear sky and pleasant weather for hundreds of miles.

In the summer of 1875, during which great quantities of ice were encountered, I began to experiment on running south to clear the fog. Probably the idea originated from my knowledge of the courses taken by the old New York and Liverpool packets, nearly all of which, on leaving Sandy Hook, in the spring and summer months, steered east by south true until they were to the eastward of 70° longitude, and crossed the 50th meridian very rarely to the northward of 43° latitude, and generally in 42° or south of that parallel. In the course of one or two seasons, on comparing our logs of previous years and those of other steamers leaving about the same dates, with our logs on the southerly route, the conviction became irresistible that crossing 50° west to the southward of 41° latitude was the safest course eastward bound. I am fully aware of the many arguments that may be used against this southern route for both east and west bound steamers; among others, the Gulf Stream, the longer distance, the discomfort to passengers in a crowded ship, the excessive heat in the fire-room, and probably many others; but, after much attention to the subject, I am convinced that these objections are more than counterbalanced by almost certain immunity from fog and ice, or the assurance that, if the latter is encountered, it will be in clear weather. I have therefore continued crossing the meridians of 50° and 45° farther to the southward every year during the ice-months, until in the present year (1882), after having made ten passages east and west, from March to August inclusive, only one hour and thirty-one minutes of fog has been encountered between Cape Henlopen and Cape Clear on the eastern passages, and that was experienced in 65° west in the month of March; and, on the western passages, nine hours and forty-three minutes in May, to the westward of 70° longitude, and six hours and thirty-six minutes in August, between the 23d and 33d meridians; while not a particle of ice has been seen during the entire season. Bergs have no doubt been reported to the southward of these tracks this year, but very rarely, and so few of them reach this latitude that the chances of seeing any are very small.

What this immunity from fog and ice means may be appreciated by any one, landsman or sailor, who will take the trouble to look over the files of the "New York Herald" for the "reports" of arrivals of steamers, or those of the New York "Maritime Register," where their logs are published. Here are a few, selected at random:

"Steamer 'Emberiza' (Br.), Dundee, February 12th, *via* Halifax: February 25th, 8 P. M., while running before a strong easterly wind with a heavy sea, got into immense quantities of field-ice; hauled ship to southeast and east to clear it; steamed slow all night, and received some damage to bows while clearing the ice, ship making a little water in fore compartment; 28th, 8 A. M., after three days' slow steaming, during which time the ship was at times completely blocked, passed a small iceberg and the last of the ice."—*New York Herald, March 7th.*

"Steamer 'Nevada' (Br.), Liverpool: April 12th, passed several large icebergs, and great quantities of field-ice."—*Ibid., April 24th.*

"Halifax, April 26th: The steamer 'Mark Lane' left Dundee, . . . thirty-six days ago. Three weeks ago the ice was sighted and every effort was made to keep away from it, but without success, and the steamer was soon in the midst of a vast field, with a very slight prospect of an early escape. From then until last Monday, although clear water would sometimes be reached for a short time, ice was never lost sight of. . . . Shortly after getting into the ice the coal on board gave out. . . . All the wood available was then obtained and burned, and at last the shipping (shifting?) boards had to be cut away, and even the top-mast broken up for fire-wood."—*Ibid., about April 27th.*

"Steamer 'Daniel Stienmann' (Belg.), Antwerp, April 12th: Had strong southwest winds to longitude 40°; thence variable winds, foggy and misty weather. April 25th, passed a large iceberg; 28th, saw a large iceberg, and subsequently passed fifteen others, also an ice-field ten miles long; steered one hundred miles southwest by west one half west (south 37° west true?), when the last iceberg was passed."—*Ibid., May 2d.*

"Boston, May 1st: The British steamer 'Glamorgan,' of the Warren line, arrived here this morning from Liverpool. . . . About four o'clock on the morning of the 26th (April), while going eleven knots an hour, she ran into a field of pack-ice and icebergs; . . . a run of twenty miles was made to the southeast, when the ship was put on her course again. She steamed one hundred and sixty miles on the southern edge of the field-ice, and during that time passed fully one hundred large icebergs. . . . The course of the vessel was changed, as the presence of the ice made it necessary, and a long passage was the result."—*Ibid., May 2d.*

"Steamer 'Jason' (Dutch), Amsterdam, April 20th: May 1st, fell in with ice, and remained in it three days; passed numerous very large icebergs; had a hole stove in fore-peak."—*Ibid., May 12th.*

"Steamer 'India' (Ger.): May 24th, passed two icebergs during a dense fog. Slowed engines until next morning, when fog lifted and found vessel surrounded by icebergs; counted thirty-five of them. The fog shut down again, and was obliged to stop vessel several times. At 10 A. M. struck an iceberg and stove two holes in starboard bow. The last ice was seen in latitude 42° 35′, longitude 52°, when three bergs were passed."—*Ibid., May 31st.*

"Steamer 'America' (Ger.), . . . was detained on the Banks and vicinity many hours by fog. June 10th, latitude 42° 30′, longitude 50° 36′, passed through a regular fleet of icebergs, one of them at least three hundred feet high; . . . weather thick and foggy, and was obliged to proceed slowly."—*Ibid., June 14th.*

"Steamer 'State of Nebraska' (Br.) was detained thirty hours on the Banks by dense fog."

"Steamer 'Devonia' (Br.) was detained eighteen hours by dense fog."—*Ibid., July 19th.*

"Steamer 'Polaria' (Ger.) had strong westerly gales and high head-seas with dense fog nearly all the passage."—*Ibid., July 20th.*

"Steamer 'Devon' (Br.) sighted a large iceberg on the eastern edge of the banks; thence light winds and fog."—*Ibid., July 23d.*

"'Abyssinia' left Liverpool June 3d: June 11th, light wind and dense fog, passed several icebergs, engines slowed and stopped; 12th, light winds and dense fog, passed several icebergs; 13th, light southeast winds and fog, passed several icebergs, engines slowed."—*New York Maritime Register, June 21st.*

The above are only a few of the many instances of steamers encountering fog and ice during the last season, and sustaining more or less damage. It is difficult which to most admire, the skill and seamanship exercised in extricating some of these vessels from difficult and dangerous situations, or the pertinacity with which they continued, month after month, to follow the same track in the face of the reports published day after day in the "Herald" and "Maritime Register," with hardly any intermission, from March to August. It may be replied that the last spring and summer have been exceptional ones for ice, which is doubtless true; but, since 1875, including that year eight seasons, we have had, for the first year, ice down very early; field-ice and bergs were seen in February, and continued into September and October. For 1876, bergs and field-ice seen in the early part of the year, February; and in August, September, and October an immense number of bergs on the Banks and to the northward of them. During the three following years, very few seen; only occasional bergs, including the one seen by the Arizona in November, 1879. In the season of 1880 there was a constant stream of icebergs along the eastern edge of the Grand Bank from March until July, some of them having been seen as far south as 40° latitude. In 1881, occasional bergs; and the ice and fog of the last season are too recent to have been as yet forgotten. Here we have, out of eight seasons, four in which ice was almost certain to be encountered from two to six months in each spring and summer. In those seasons during which very little ice was reported, how was it to be known at what moment it might not have been fallen in with? As we have seen above, in some years the ice comes down in February; perhaps the next year not until September. Can any one doubt that, the longer we continue to run without seeing ice, the more emboldened we become to continue running through the region where it is liable to be met with, in all kinds of weather, trusting partly to our escape from accident in the past for security in the future? If this is not so, the nature of shipmasters must be different from ordinary human nature; and that the observation is a true one is, I think, proved by the experience of the past season, when so many steamers continued to round the south end of the Grand Bank, voyage after voyage, in a latitude where ice was almost as certain to be encountered as the sun was sure to rise in the morning; and when it was also as certain that, by crossing the meridian of 50° a hundred miles farther to the southward, the ice could have been avoided altogether.

The facts appended are the result of careful observations, taken from June, 1875, to August of last year. The instruments were compared frequently with standards, the temperature of the water taken at least every hour, and, when changes were anticipated, sometimes every ten minutes, between Henlopen and Cape Clear, and the hours and minutes of fog noted when the whistle was blowing or when we could not see far enough to clear a vessel without difficulty. I presume it will be conceded that many more hours of hazy or misty weather would be encountered on the northern than on the southern route; the vicinity of the colder water naturally bringing with it more hours when a vigilant lookout would have to be kept, but when it would not be necessary for the steam-whistle to be sounded. The observations comprise thirty-two eastern and twenty-seven western passages, from March to August inclusive, on routes one to five, and five western passages in August, *via* Cape Race, on the middle of the Bank. The eastern passages, from 1875 to 1879, were sailed on track No. 3, which crosses the 50th meridian in about 41° latitude, and hauls sharp to the northward, on the Great Circle for the Fastnet. For 1880–'81 track No. 4 was followed, with the exception of the March passage in 1881, when 50° longitude was crossed in 42° latitude, thereby reducing slightly the average distance for the season. During the season of 1882, track No. 5 was taken from April to August.

On the western passages, track No. 1, the route generally taken in these months, was followed as closely as possible from 1875 up to and including the June trip of 1880. The July passage of that year was made on track No. 4. For the year 1881 the earliest trip, April, was made on track No. 1; the subsequent passages on No. 4. During the present year, with the exception of the March trip, the passages have been made entirely on the extreme southern track, No. 5.

In following track No. 4, on eastern passages 56 and 63, six hours and forty minutes of fog was encountered between 40° and 60° longitude, and on the western passages 56, 63, and 64, nine hours and fifty-one minutes between the same meridians. This fog, on these five passages, was found always very near the 48th meridian; the mean temperature of the surface-water, while the weather continued foggy, being 53° Fahr. in the early part of July, and 65° in the latter part of the same month; falling in a few moments from, and rising as rapidly to, 89° in the former and 78° in the latter instance. This belt of cold water, and of fog, which was entirely avoided on route No. 5 in 1882, is described in Maury's "Physical Geography of the Sea." In writing of the Gulf Stream and climates of the ocean, he says: "Navigators have often been struck with the great and sudden changes in temperature of the waters hereabout; . . . this 'bend' is the great receptacle of the icebergs which drift down from the north; covering frequently an area of hundreds of miles in extent, its waters differ as much as 20°, 25°, and in rare cases as much as 30° in temperature from those about it. Its shape and place are variable. Sometimes it is like a peninsula, or tongue of cold water, projected far down into the waters of the Gulf Stream." In May, 1881, on track No. 4, the width of this "tongue" was about fifty miles, and on the following passage in June less than thirty miles. On the latter passage I was enabled to predict its position with such certainty that I struck it inside of half an hour of the time expected. All the fog experienced on track No. 4 between the 40th and 60th meridians has been met with in this immediate vicinity. With the limited number of observations, taken only on one ship, it would no doubt be premature to give an opinion as to the fixed locality of this tongue of the Arctic current; but I can nevertheless confidently affirm that between 40° and 60° longitude, the tables below, with the observations of the temperature of the surface-water, show, beyond dispute, that by an additional hundred miles of distance, the chances of meeting fog in the spring and summer months are almost, if not entirely, avoided. Whether it is worth the loss, from the additional distance, to escape fog and very nearly all the ice, is a question for each to decide for himself.

The following table shows the hours of fog and distance sailed on the voyages described above:

TRACK No. 1.—43° latitude, 50° longitude, to Fastnet on the Great Circle.

No. 2.—42° latitude, 50° longitude, to Fastnet on the Great Circle.

No. 3.—41° latitude, 50° longitude, to Fastnet on the Great Circle.

No. 4.—41° latitude, 50° longitude, to 42° latitude, 45° longitude, thence to Fastnet on Great Circle.

No. 5, East.—40° 30′ latitude, 50° longitude, to 41° latitude, 47° longitude, thence to Fastnet on Great Circle.

No. 5, West.—Fastnet to 41° latitude, 47° longitude, thence to 40° latitude, 50° longitude, thence to Cape Henlopen.

EASTERN PASSAGES.

VOYAGE.	Month.	Hours of Fog. Total.	Hours of Fog. Between 40° and 60° W.	Distance sailed.
		Hours. Min.	Hours. Min.	Miles.
		1875.		
13	June	0 0	0 0	2,995
14	July and August	0 0	0 0	2,979
2 passages		0 0	0 0	5,974
Average		0 0	0 0	2,987
		1876.		
20	March and April	0 0	0 0	2,995
21	May	0 0	0 0	2,988
22	June	23 15	20 45	2,978
23	July and August	8 0	8 0	2,955
4 passages		31 15	28 45	11,916
Average		7 49	7 11	2,979
		1877.		
29	April	0 0	0 0	2,982
30	June	8 0	0 0	2,975
31	August	0 0	0 0	2,944
3 passages		8 0	0 0	8,901
Average		2 40	0 0	2,967
		1878.		
36	March	0 0	0 0	2,987
37	April and May	10 45	0 0	2,990
38	June	17 45	17 45	2,989
39	July	13 39	0 0	2,950
4 passages		42 9	17 45	11,916
Average		10 32	4 26	2,979
		1879.		
45	April	0 0	0 0	2,962
46	May	5 52	3 50	2,988
47	June	4 15	4 15	2,974
48	July	8 43	0 0	2,988
4 passages		8 50	8 5	11,892
Average		4 42	2 1	2,973
		1880.		
53	March	0 0	0 0	2,995
54	April	0 0	0 0	2,997
55	May	8 0	0 0	2,999
56	June and July	7 0	3 0	3,005
57	August	0 0	0 0	2,991
5 passages		15 0	3 0	14,987
Average		3 0	0 36	2,997
		1881.		
62	March	2 35	2 35	2,959
63	April and May	3 40	3 40	2,984
64	May and June	8 58	0 0	3,025
65	July	2 54	0 0	3,018
66	August	0 0	0 0	2,971
5 passages		18 7	6 15	14,957
Average		3 37	1 15	2,991

EASTERN PASSAGES—(*continued*).

VOYAGE.	Month.	Hours of Fog. Total.	Hours of Fog. Between 40° and 60° W.	Distance sailed.
		Hours. Min.	Hours. Min.	Miles.
		1882.		
71.	March	1 31*	0 0	3,005
72.	April	0 0	0 0	3,016
73.	May	0 0	0 0	3,026
74.	June and July	0 0	0 0	3,025
75.	July and August	0 0	0 0	3,025
5 passages		1 31	0 0	15,097
Average		0 18	0 0	3,019

WESTERN PASSAGES.

VOYAGE.	Month.	Hours of Fog. Total.	Hours of Fog. Between 40° and 60° W.	Distance sailed.
		Hours. Min.	Hours. Min.	Miles.
		1875.		
13.	July	18 5	0 0	2,945
1 passage		18 5	0 0	2,945
		1876.		
20.	April	15 15	9 35	2,950
21.	May and June	44 55	16 45	2,935
22.	July	53 33	5 20	2,902
3 passages		113 43	31 40	8,787
Average		37 54	10 33	2,929
		1877.		
28.	March	16 0	0 0	2,913
29.	May	4 0	4 0	2,915
30.	July	39 0	26 0	2,908
3 passages		59 0	30 0	8,736
Average		19 40	10 0	2,912
		1878.		
36.	March and April	23 30	17 0	2,920
37.	May	36 13	24 28	2,925
38.	June and July	10 19	0 0	2,918
3 passages		70 2	41 28	8,763
Average		23 21	13 49	2,921

All these passages on track No. 1, *via* 43° latitude, 50° longitude.

* In longitude 65° west, between tracks No. 2 and No. 3.

WESTERN PASSAGES.

VOYAGE.	Month.	Hours of Fog. Total.	Hours of Fog. Between 40° and 60° W.	Distance sailed.
		Hours. Min.	Hours. Min.	Miles.
		1879.		
44	March	5 16	0 0	2,917
45	April	4 35	0 0	2,913
46	May and June	17 30	12 0	2,919
47	July	10 50	0 30	2,912
4 passages		38 11	12 30	11,661
Average		9 33	3 7	2,915
		1880.		
53	March	2 30	2 30	2,912
54	May	22 25	11 15	2,915
55	June	0 0	0 0	2,917
56	July	8 0	8 0	3,019
4 passages		32 55	21 45	11,763
Average		8 14	5 26	2,941
		1881.		
62	April	12 20	12 20	2,907
63	May	3 5	1 15	3,023
64	June	3 41	0 36	3,020
65	July and August	0 50	0 0	3,011
4 passages		19 56	14 11	11,961
Average		4 59	3 33	2,990
		1882.		
71	March and April	0 0	0 0	3,016
72	May	9 43*	0 0	3,024
73	June	0 0	0 0	3,026
74	July	0 0	0 0	3,026
75	August	6 36†	0 0	3,026
5 passages		16 19	0 0	15,118
Average		3 16	0 0	3,024

CAPE RACE PASSAGES.

VOYAGE.	Year.	Month.	Hours of Fog. Total.	Hours of Fog. Between 40° and 60° W.	Distance sailed.
			Hours. Min.	Hours. Min.	Miles.
14	1875	August	26 5	10 50	2,861
23	1876	August	5 30	5 30	2,862
31	1877	August	5 30	2 30	2,853
39	1878	August	23 51	1 15	2,857
48	1879	August	0 30	0 0	2,856
5 passages			61 26	20 5	14,289
Average			12 17	4 1	2,858

The comparisons for the different years, omitting the Cape Race passages, are as follows:

* West of 70° longitude. † Between 23° and 33° west.

EASTERN PASSAGES.

YEAR.	Number of passages.	Hours of Fog.				Average distance sailed, per passage.
		Total.	Average, per passage.	40° to 60° W.	Average, per passage.	
		Hours. Min.	Hours. Min.	Hours. Min.	Hours. Min.	Miles.
1875......	2	0 0	0 0	0 0	0 0	2,987
1876......	4	31 15	7 49	28 45	7 11	2,979
1877......	3	8 0	2 40	0 0	0 0	2,967
1878......	4	42 9	10 32	17 45	4 26	2,979
1879......	4	18 50	4 42	8 5	2 1	2,973
1880......	5	15 0	3 0	3 0	0 36	2,997
1881......	5	18 7	3 37	6 15	1 15	2,991
1882......	5	1 31	0 18	0 0	0 0	3,019

WESTERN PASSAGES.

YEAR.	Number of passages.	Hours of Fog.				Average distance sailed, per passage.
		Total.	Average, per passage.	40° to 60° W.	Average, per passage.	
		Hours. Min.	Hours. Min.	Hours. Min.	Hours. Min.	Miles.
1875......	1	18 5	18 5	0 0	0 0	2,945
1876......	3	113 43	37 54	31 40	10 33	2,929
1877......	3	59 0	19 40	30 0	10 0	2,912
1878......	3	70 2	23 21	41 28	13 49	2,921
1879......	4	38 11	9 33	12 30	3 7	2,915
1880*.....	4	32 55	8 14	21 45	5 26	2,941
1881†.....	4	19 56	4 59	14 11	3 33	2,990
1882‡.....	5	16 19	3 16	0 0	0 0	3,024

By the above tables the average hours of fog for each passage show a decrease in the eastern passages from seven hours forty-nine minutes in 1876 and ten hours thirty-two minutes in 1878, to three hours, and three hours and thirty-seven minutes in 1880 and 1881, and eighteen minutes in 1882 ; and between the sixtieth and fortieth meridians, the ice-region, from an average of seven hours eleven minutes in 1876 to one hour fifteen minutes in 1881, and an entire immunity from fog in 1882 ; for the western passages a decrease from an average of thirty-seven hours fifty-four minutes of each passage in 1876 to four hours fifty-nine minutes in 1881, and three hours sixteen minutes in 1882 ; while in crossing the ice-region the average is reduced from ten hours thirty-three minutes in 1876 to three hours thirty-three minutes in 1881, and an entire absence of fog in 1882.

Comparing the western passages *via* 43° latitude, 50° longitude (route No. 1), with the extreme southern passages (routes 4 and 5), the result is as follows :

* One passage, southern route (track No. 4).

† Two passages, southern route (track No. 4).

‡ One passage, southern route (track No. 4). Four passages, southern route (track No. 5).

WESTERN PASSAGES,

via 43° latitude, 50° longitude. (Route No. 1.)

VOYAGE.	Month.	Hours of Fog. Total.		Hours of Fog. 40° to 60° W.		Distance sailed.
		Hours.	Min.	Hours.	Min.	Miles.
13	July	18	5	0	0	2,945
20	April	15	15	9	35	2,950
21	May and June	44	55	16	45	2,935
22	July	53	33	5	20	2,902
28	March	16	0	0	0	2,913
29	May	4	0	4	0	2,915
30	July	39	0	26	0	2,908
36	March and April	23	30	17	0	2,920
37	May	36	13	24	28	2,925
38	June and July	10	19	0	0	2,918
44	March	5	16	0	0	2,917
45	April	4	35	0	0	2,913
46	May and June	17	30	12	0	2,919
47	July	10	50	0	30	2,912
53	March	2	30	2	30	2,912
54	May	22	25	11	15	2,915
55	June	0	0	0	0	2,917
62	April	12	20	12	20	2,907
18 passages		336	16	141	43	52,543
Average		18	41	7	52	2,919

WESTERN PASSAGES,

via Southern Route. (Nos. 4 and 5.)

VOYAGE.	Month.	Hours of Fog. Total.		Hours of Fog. 40° to 60° W.		Distance sailed.
		Hours.	Min.	Hours.	Min.	Miles.
56	July	8	0	8	0	3,019
63	May	3	5	1	15	3,023
64	June	3	41	0	36	3,020
65	July and August	0	50	0	0	3,011
71	March and April	0	0	0	0	3,016
72	May	*9	43	0	0	3,024
73	June	0	0	0	0	3,026
74	July	0	0	0	0	3,026
75	August	†6	36	0	0	3,026
9 passages		31	55	9	51	27,191
Average		3	33	1	6	3,021

and the comparative loss of distance as under

	Miles.
Average distance lost each western passage	102
Average distance lost in nine passages	918

To compensate for which loss of distance, we have—

	H.	M.
Average of fog per passage on the northern route (track No 1)	18	41

* West of longitude 70°. † Between 23° and 33° west.

reduced to—

	H.	M.
Average of fog each passage on the southern route...........	3	33

and—

Average of fog each passage through the ice-region by former route...	7	52

reduced to—

Average of fog each passage through the same by latter route..	1	6

and, omitting the fifty-eighth voyage, have actually an average of only fourteen minutes of each passage for eight passages through the whole region of the Atlantic where ice is liable to be encountered. Another fact that should not be forgotten in the comparison is the maximum amount of fog liable to be met with (see twenty-second and thirtieth passages west) on the northern route (track No. 1).

Cape Race in August.—On this route for this month we have—

	MILES.
Average distance sailed each passage.........................	2,858
Average distance sailed each passage by extreme southern route.	3,021
Loss of distance each passage	163

Against which loss of distance, we find the average of fog as above, instead of—

	H.	M.
Average hours of fog, Cape Race..........................	12	17
Average hours of fog through the ice-region................	4	1

and—

Maximum amount of fog on thirty-ninth voyage	23	51

As I have seen ice on three out of five of these August passages *via* Cape Race, it is an open question which is the best route for this month in ordinary years. Where the ice has continued so late as in the present season, I should certainly prefer the southern route. Below is the report of the steamer Main (Ger.), *via* Cape Race, in July of the present year, arriving in New York on the 20th of that month: "Passed Cape Race July 18th; . . . from Sable Island to Sandy Hook had continuous fog; July 19th (?) latitude 47° 45′, longitude 48° 12′, passed an iceberg; same date, latitude 46° 56′, longitude 52° 24′, up to Cape Race, for a distance of thirty miles numerous large and small icebergs; same date, latitude 46° 11′, longitude, 53° 54′, two large icebergs."

Currents.—I was much surprised, on comparing the total distances, by observation and account, for these westerly passages, to find that the average current was less on the southern than on the northern route.

The following shows the comparison for the twenty-seven westerly passages:

CURRENT ON WESTERN PASSAGES,

via latitude 43°, longitude 59°. (Track No. 1.)

VOYAGE.	Month.	Distance.		Current.	
		Observed.	Account.	East.	West.
		Miles.	Miles.		
13	July	2,945	3,071	126	..
20	April	2,950	2,942	..	8
21	May and June	2,935	3,010	75	..
22	July	2,902	2,948	46	..
28	March	2,913	2,901	..	12
29	May	2,915	2,867	..	48
30	July	2,908	2,948	40	..
36	March and April	2,920	2,920	..	..
37	May	2,925	2,848	..	77
38	June and July	2,918	2,935	17	..
44	March	2 917	2,939	22	..
45	April	2,913	2,925	12	..
46	May and June	2,919	2,909	..	10
47	July	2,912	2,967	55	..
53	March	2,912	2,879	..	33
54	May	2,915	2,904	..	11
55	June	2,917	3,015	98	..
62	April	2,907	2,977	70	..
18 passages		52,543	52,905	561	199
Difference			362	easterly	
Average per passage			20		

CURRENT ON WESTERN PASSAGES,

via Southern Route. (Tracks Nos. 4 and 5.)

VOYAGE.	Month.	Distance.		Current.	
		Observed.	Account.	East.	West.
		Miles.	Miles.		
56	July	3,019	3,015	..	4
63	May	3,023	2,973	..	50
64	June	3,020	3,068	48	..
65	July and August	3,011	3,046	35	..
71	March and April	3,016	3,028	12	..
72	May	3,024	3,009	..	15
73	June	3,026	3,056	30	..
74	July	3,026	3,056	30	..
75	August	3,026	3,027	1	..
9 passages		27,191	27,278	156	69
Difference			87	easterly.	
Average for passage			10		

As long as our navigation laws of the last century continue unrepealed, probably the facts contained in the above tables will be of little interest to steamship-owners in the United States; but underwriters and shippers are certainly concerned, as to the proportion of steamers in the North Atlantic trade that escape from or meet with detention, accident, or loss. The immense proportions that the traffic between Europe and the United States is bound to assume within the next fifty years appear to make it almost a necessity that the ocean between the two countries should be as well known as the country between New York and San Francisco, or between Liverpool and London. That this subject has been almost a matter of indifference to the governments interested, until very recently, can not be better illustrated than by the fact, almost incredible, but nevertheless true, that a shoal on the eastern edge of the Grand Bank, directly in the track of steamers running between the two countries for the greater portion of the year, marked "Ryder Rock, twenty-one feet, position doubtful," was laid down on the charts published by the British Admiralty and United States Hydrographic Offices, until 1879, in which year the bank was resurveyed, and the shoal found to have had no existence. The United States and British Governments have recently spent thousands of dollars in Arctic explorations and relief expeditions, one of the results of which has been to show how gallantly death can be encountered. Surely, a few thousands would be well expended in the survey of this ocean highway on which thousands of lives are constantly afloat; and certainly government ships might be worse employed than in an attempt to give greater security to life and property on its treacherous surface.

If the publication of these two articles * should be the means of causing one ship-master to try the southern route, or deter one steamer from ramming into an ice-field on the eastern edge of the Grand Bank, in the spring of the year, the writer will be amply repaid for any time and trouble they may have cost him.

REMEDIAL VALUE OF THE CLIMATE OF FLORIDA.

BY GEORGE E. WALTON, M. D.,

MEMBRE DE LA SOCIÉTÉ FRANÇAISE D'HYGIÈNE, PARIS, ETC.

"Know ye the land of the cedar and vine,
Where the flowers ever blossom, the beams ever shine,
. . . .
Where the citron and olive are fairest of fruit,
And the voice of the nightingale never is mute?"

WHEN one approaches this land, from the northward, in the winter season, having left the hills and valleys about his home covered with the cold, white mantle of winter, he is pleased and cheered by the green foliage. The breezes which touch him possess a delicious softness and a fragrant, spicy aroma. When, at the shores of the St. John's River, he looks over miles of clear and unruffled

* See the first article, in "Harper's Magazine" for August, 1882.

water, many miles in width, like an inland lake, and reaching far away, hundreds of miles to the south, fringed by green inlet and headland, bearing the tropical foliage of cypress and orange, palmetto and palm; when the mild sunshine, falling so softly upon forest, bank, and river, has penetrated him till he feels a gentle warmth flowing through his veins; when a delicious languor has possessed him, and it would seem perfect happiness to rest in the genial sunshine forever—then he knows he has found the sweet do-nothing land of America.

Warmth is life, cold is death, and the medical study of climate is only an analysis of those conditions of heat which will best secure an abounding vitality in the healthy human organism, or restore a shattered organism to its normal physical relations.

Men, like children, continually cry for the unattainable. We would like a land in which a perfect June always prevails.

What are the factors in the climate of Florida? Heat, water, and light—warmth, moisture, and sunshine.

The health resort of Florida is the peninsular portion, averaging one hundred miles in width and projecting southward over three hundred miles, amid the waters of the Atlantic Ocean and Gulf of Mexico.

It is a flat land, composed almost entirely of sand. So much does it resemble a jetty of sand, such as we see formed at the confluence of streams, that it may appropriately be termed an ocean sand-bar, with everglades, marshes, and lagoons in the southern portion, testifying how recently, geologically speaking, it has emerged from the depths of the sea. Around this sickle-shaped peninsula the Gulf Stream, with an average temperature of 86° Fahr., sweeps from the southernmost point along the eastern shore at a distance of ten to one hundred miles from the coast. Across it the salt-laden breezes of the ocean continually play, by day and by night. Upon it the warm rays of a semi-tropical sun almost continually shine.

What are the results of these physical conditions, stated in the exact terms of meteorological science? For this purpose it is not necessary to array long tables of average temperature, mean monthly range, rain-fall, barometric pressure, relative humidity, etc.

It is sufficient to know that the average temperature of Jacksonville, for the month of November, is 61° Fahr.; December, 54° Fahr.; January, 55° Fahr.; February, 57° Fahr.; March, 62° Fahr. The rainfall in November is 3½ inches; December, 3 inches; January, 3 inches; February, 2½ inches; March, 4½ inches. St. Augustine, Palatka, and Gainesville average 2° or 3° warmer than Jacksonville. At St. Augustine the rain-fall is less than at Jacksonville, being, November, 1·2 inch; December, 2 inches; January, 2 inches; February, 1·6 inch; March, 2·3 inches. The mean monthly range of temperature for these places during the winter months is between 20° and 30° Fahr.

These figures indicate a mild, equable, and sunshiny climate during winter for all that portion of Florida frequented by invalids, embracing a region on the east side of the State, from Jacksonville as far south as Palatka. For a country lying on a parallel with the Canaries, off the coast of Africa, they indicate a climate which in temperature approaches that of Malaga, Malta, and Algiers, but does not nearly equal them in evenness and unchangeableness, though, in point of clear, sunshiny weather, far superior.

However, from the facts given, we are unable to fix accurately the position of the Florida climate. We neither know the atmospheric humidity nor the electrical potential; and, as yet, the phenomena of nature have not been interrogated for an answer.

A cardinal question is whether the climate be moist or dry, bracing or relaxing.

It may not be amiss to note here an error committed by a professional gentleman of Jacksonville.* In a pamphlet on the climatology of Florida, he gives tables of the mean relative humidity of Jacksonville and other stations in Florida, and attempts to prove therefrom, by comparison with similar observations in Northern States, that the atmosphere of Florida is *dry*, much drier than that of Minnesota, Mount Washington (New Hampshire), Alpina (Michigan), Omaha (Nebraska), and other Northern localities. It should be remembered, however, that there is a wide difference between *relative humidity* and *absolute humidity*, and their relation is frequently diametrically opposite. Relative humidity does not indicate the amount of vapor present in the air per cubic foot, but only the tendency to deposit it in a wet state on a surface but little lower in temperature than the surrounding atmosphere. Absolute humidity, on the contrary, is the actual amount of vapor present in each cubic foot of air. To illustrate, suppose the cubic foot of air to be a hollow cubic vessel of tin. Absolute humidity is the actual amount of watery vapor contained in that tin vessel. Relative humidity is the tendency of that vapor, be it great or small in quantity, to leak out of the vessel and show itself on the outside in the form of mist or dew. Sir John Herschel says, "As a general meteorological fact, there is not merely a want of accordance, but an actual opposition between both the diurnal and annual progress of the 'degree of humidity' or 'relative humidity' of the air and the 'tension of vapor' as indicated by hygrometric observation, a seeming paradox, but one very easily explained." † He then shows how the relative humidity is greatest just before sunrise of each day, and the vapor tension or absolute humidity is least; that as the day advances the relative humidity diminishes and the absolute humidity increases, till the maximum temperature of the day is reached, when absolute humidity is greatest and relative humidity is least. It is also well to know, in considering this question, that air at a temperature of 60° Fahr. is capable of containing double the quantity of vapor by weight

* Dr. J. C. Kenworthy.

† "Meteorology," by Sir John F. W. Herschel, Edinburgh, 1861, p. 193.

that it is at a temperature of 40° Fahr., and this ratio continues throughout the thermometric scale. Whether air at an average high temperature, like that in Florida, will contain this excess of moisture, depends only on the proximity of water whence the vapor may be obtained.

The figures of relative humidity recorded by the Signal Service at Jacksonville only indicate the ratio in per cent which the humidity of the air at the time bears to *saturated air at the same temperature.* But the weight of vapor in saturated air at that temperature is not given, therefore the absolute value of this percentage, so far as the records are concerned, is unknown. The basis for the calculation is, however, easily obtainable—the weight of vapor in troy grains, contained in saturated air at different temperatures (Glaisher's Table)—and will be found to increase in an ascending scale from zero. The following record of the Signal Service in Cincinnati, Ohio (Sergeant R. B. Watkins, U. S. A., observer), well illustrates the subject:

TEMPERATURE AND HUMIDITY.	7 A. M.	10·30 A. M.	2 P. M.	2·30 P. M.	9 P. M.	10·30 P. M.	Average.
JANUARY 1, 1881:							
Thermometer, degrees Fahr.....	4	12	27·5	29·5	30	28	21·8
Relative humidity, per cent.....	74	61	76	73	68	77	71·5
Actual humidity, grains........	0·44	0·59	1·35	1·35	1·35	1·41	1·08
JUNE 1, 1881:							
Thermometer, degrees Fahr.....	73	78	79	80	70	69	74·8
Relative humidity, per cent.....	72	61	54	51	80	85	67·1
Actual humidity, grains........	6·36	6·46	5·95	5·76	6·41	6·57	6·25

From the above table we see that on a day of high temperature and low relative humidity there was nearly six times more vapor in the air than on a day of low temperature and high relative humidity.

By way of comparison we here insert a table showing the mean annual and winter temperature, also the relative humidity and absolute humidity, of three winter stations. It shows the average quantity of vapor in the air at Jacksonville, throughout the year, to be twice as great as at St. Paul, Minnesota, and four times more during the winter season:

STATIONS.*	Altitude.	Annuals.			Winter months: November, December, January, February, March.		
		Temperature.	Relative humidity, per cent.	Absolute humidity, per cubic foot.	Temperature.	Relative humidity, per cent.	Absolute humidity, per cubic foot.
	Feet.	Deg. F.		Grains.	Deg. F.		Grains.
Jacksonville, Florida ..	20	68·98	71·0	5·48	58·17	70·6	3·81
San Antonio, Texas ...	600	69·6	68·1	5·36	56·63	68·6	3·51
St. Paul, Minnesota....	800	42·32	68·4	2·12	20·17	70·9	0·92

* The temperature of these places is from the "Smithsonian Temperature Tables." The relative humidity is calculated from data of five years—1877-1881 inclusive—supplied the writer by the Chief Signal-Officer, General W. B. Hazen, Washington, D. C.

In consideration of these facts, we are compelled to cast aside tables of "relative humidity" as valueless when taken alone, for the purpose of determining the humidity of climates. The physical properties of vapor in the air—the absolute humidity—are essential elements which can not be ignored, and are of exceeding significance in the treatment of disease.

We have given prominence to this topic, inasmuch as the pamphlet of Dr. Kenworthy is widely circulated by the Bureau of Immigration of the State of Florida, and is quoted in a pamphlet on Florida issued by the United States Department of Agriculture, and also in the well-known work on Florida by G. H. Barbour, as establishing conclusively the dryness of the climate. It well shows how figures, correct in themselves, may, by misapprehension of their import, become the source of mischievous error.

Given—a peninsular land subjected to the burning rays of a semi-tropical sun and surrounded by an ocean of warm water, the average temperature of which is 77° Fahr.*—then it is not necessary to ask the Signal Service whether the climate be moist or dry. If they supplied us with tables of absolute humidity, they could only add to our information accurate knowledge of the excess of moisture. Every breeze that blows touches the face with the softness of a moist May morning at the North. The atmosphere is delicious, balmy.

In addition to physical sensation and deductions drawn from geographical position, there are other reasons for deciding that the climate is moist. The necessity of frequently emptying closets during the summer season, and drying clothing-apparel ; the impossibility of using cellars, because of the quickness with which mold destroys goods there stored ; the thick formation of *vert-de-gris* on articles of brass ; the rapid decay of structures made of wood, as compared with Northern localities ; the presence almost everywhere of the Southern moss (*Tillandsia*), swaying in festoons from the trees—these facts tell of excessive atmospheric moisture.

Sunshine, which is so cheering to the invalid, and the absence of which is so depressing even to the well, is abundant in Florida. There it glitters continually on leaf and flower. Five years' observation at Jacksonville shows an average of only seven cloudy days for each winter month, the other twenty-three being arched by a soft Italian-like sky.

What relation electrical potential may have to climate as regards

The absolute humidity is calculated from "Table X" of "Smithsonian Meteorological Tables," by Guyot, giving weight of vapor in grains troy, contained in a cubic foot of saturated air between 0° and 105° Fahr.

* The temperature of the surface-water of the Gulf of Mexico, off Key West, in May, was 77½° Fahr., as determined by the United States Coast Survey, 1857, p. 102.

The average temperature of the St. John's River, at Jacksonville, to the depth of eighteen feet, determined by daily observations by Sergeant J. W. Smith, United States Signal Service, from September, 1881, to March, 1882, is 70° Fahr.

its so-called elasticity or bracing properties is yet undetermined. That it is continually fluctuating, and that it varies considerably at different places, is known. When instruments shall have been devised by which this element can be accurately recorded, we may then discover that those climates which are termed bracing possess special peculiarities as to electrical distribution.

We then estimate the climate of Eastern Florida to be mild in winter temperature, moist, sunshiny, relaxing, and for an American climate equable, though not to be compared in this respect with the Genoese Riviera.

What is the value of this climate in the treatment of disease?

We will first consider that scourge of overcrowded populations—*consumption*—a disease which is limited to no zone, and for which the benefit of change of climate is most frequently sought. The discoveries of Koch, of Berlin, in his researches on the cause of this disease, may, if they are satisfactorily confirmed, enable us in the future to interpose barriers to its invasion. They may also enable us to eliminate "taking cold" as one of the causes of consumption. But they will not change the nature of the *bacillus tuberculosis*, the habits of which, although itself unknown, have been familiar to the world for many centuries. Persons of feeble constitution, whether hereditary or acquired, will still be the subjects of its incursion, and the disease engendered by its presence will require the same treatment as heretofore, unless happily we find a remedy which will destroy these morbific germs *in situ*, and thus, by relieving the patient of the exciting cause, lead to immediate recovery.

It is not necessary to cite authorities to show that the prime need of a consumptive is that he shall be a great deal out-of-doors, that he shall breathe pure air, that he shall exercise, that his entire physical organization shall be invigorated. Is the climate of Florida fitted to do this? I answer, No! The climate is simply and delightfully soothing. Being so—being moist and relaxing—it will cause tuberculous deposits to disintegrate rapidly. Expectoration will be increased, and there will be no rally of the system to oppose this new call upon the strength. Instead of exercising freely and expanding his lungs as he should, the consumptive invalid will sit listlessly on the piazzas of the hotels, awaiting his fate. Hundreds are seen, wherever you go, so doing. Seldom do you see one attempting to exercise, and, if one is seen, he is moving in that sluggish and apathetic manner so characteristic of every one living there.

It is unfortunate that, of the thousands of consumptives who go to Florida, we can get no reliable statistics of the result. The people of Florida, the owners of the soil, the railroad and steamboat owners and agents, the hotel-keepers, the physicians residing there, are all so much interested personally in the prosperity of the State, which, since the close of the war, has been opened up like a newly-discovered country, that it is well-nigh impossible for them to give unprejudiced statements concerning the healthfulness of the State, its adaptation to the cure of disease, or any other subject, which even remotely touches their personal interest. A prism is placed before your eyes, and you are caused to see everything covered with the colors of the rainbow.

However, I snatched one fragment from the page of fact. During the last six months of 1881 there were thirteen deaths in Jacksonville (population 8,000 *) from consumption, these deaths being of residents only, and excluding all non-residents or visiting invalids. This is a mortality of 1·62 per 1,000, being a greater mortality than occurred in Cincinnati during the same time, which was 4·24 in a population of 280,000, or 1·51 per 1,000. These figures do not establish the rate of mortality, from this disease, in the city of Jacksonville, for in so small a place a series extending over a number of years would be necessary. But, when facts are so difficult to find, we must content ourselves even with a straw. It is much more satisfactory to thus have an indication from a populous center, than the rate from sparsely populated country districts, which, as is well known, are comparatively immune everywhere. It may be stated, in this connection, that natives of Florida taken with consumption frequently seek other places and climates as a means of cure.

In endeavoring to show the unfitness of Florida for consumptives, I have spoken of the disease *en bloc*, and made no reference to the different types, as I believe it better to convey the impression that Florida is not suitable for any type of the disease. Possibly in the rare inflammatory kind, with dry and heated bronchial tubes and beginning laryngeal symptoms, the soothing and relaxing air of Florida may be of temporary advantage. But the forecast of such cases is seen *ab initio*, and we do not look for a cure, such as may frequently occur in cases of the more chronic sort, when proper medicinal treatment is given and a proper climate is selected.

We do not mean to say that cases of consumption never improve in Florida. Undoubtedly there are cases which get well in Florida, just as there are in every locality, and even at home.

Turning from consumption, we will look on the opposite side of the picture. Are there no diseases of the lungs in which this delightful climate is beneficial? Undoubtedly; and it is the efficacy of the climate in this other group of diseases—the bronchial, often wrongly diagnosed as consumption—that has given reputation to the climate. The "taking of cold" in Florida is a comparatively infrequent event. Even when one does take cold it is only manifested by slight sneezing, and that is the end of it. There is no tendency to acute inflammation of the Schneiderian membranes, the extension by continuity to the fauces, larynx, trachea, and bronchial tubes; in fine, to that compound

* The population of Jacksonville, including suburbs, is considerably above this, but the mortality statistics are limited to a district the population of which is as stated.

of *malaise*, difficult breathing, soreness of the chest, and cough, termed a "severe cold," which is so excessively frequent in this latitude, and which, often repeated in certain constitutions, leads to chronic inflammation and diminution of the caliber of the bronchial tubes, to dilatation of air-cells, to bronchorrhœa, and all those attendant evils which are little less baneful than consumption itself. For those in whom frequent colds have induced the condition of *chronic bronchitis*, I believe there is no better climate than Eastern Florida, and those in comparatively good health who suffer from repeated colds without other ill effects will find in that climate freedom from the inconvenience. That other condition termed *winter cough*, frequent among people advanced in years and which is little other than chronic bronchitis with a quiescent period during the summer months, will also be entirely relieved in that land. Indeed, if the person removes there for life he will soon become unconscious that he ever had such an affliction.

Chronic laryngitis, and pharyngitis granulosa, or *clergyman's sore-throat*, will also be decidedly benefited by winter sojourn or permanent residence in Florida.

In the spasmodic constriction of the bronchial tubes—*asthma*—it can only be said that many cases will be entirely relieved in Florida, while with some it will fail, and, if one is to be exiled in the interest of health, there is probably no pleasanter place for enduring semi-expatriation.

A climate of this kind is also favorable to the prolongation of the life of those afflicted with *chronic Bright's disease* of the kidneys—chronic parenchymatous nephritis. The person will be little exposed to chilling of the surface of the body, which arrests cutaneous perspiration, congests the blood-vessels of the internal organs, and forces excessive work on the already damaged cortical net-work of the kidneys.

Sufferers from *muscular* and *chronic rheumatism* find the genial warmth of this region softens the unpliable and painful muscles, and loosens the rigid tendons, while the increased secerning activity of the skin removes the morbid humor, whatever that may be.

For none do I know a land more delightful, than for him who, by long and severe mental activity, has exhausted the vital battery of nerve-force and disturbed the harmonious balance between the varied complex nerve-circuits. The person who suffers from this condition, sometimes called *nervous prostration*, and which often passes under other cognomens, will there find a panacea. The soothing softness of the climate invites to continuous repose, and for him perfect rest is a prelude to restoration ; repair of tissue gains upon waste, the nerve-currents gradually resume their normal course and vigor, and a return of health results.

Old age crawls shivering along our cheerless streets, the frigid northern blasts fluttering the garments about his attenuated limbs, chilling the blood till stasis occurs in some vital organ, and inflammation and death result. There, the old man pursues out-door life fearless of frost or intense heat, and, in a prolonged and painless existence, forgets that his summer is gone, and the snows of winter are upon his head.

In closing this paper, some reference to places in Florida most suitable for invalids may be of interest.

Leaving Jacksonville in the afternoon of any day, by one of the beautiful side-wheel steamers, the passenger, sitting on the forward guard, sees unrolled before him a semi-tropical scene. The vessel makes its way in the midst of a broad stream of placid stillness, whose shoaling shores are curved and fretted by inlet and headland, bearing above them the rich luxuriance of evergreen foliage, like a broad mirror festooned with myrtle and vine. Often, so far away from the course of the boat are the distant shores that one may with difficulty descry the towns and houses which are indicated in the distance. For seventy-five miles and more to the southward the river retains this similitude to a broad and extended lake. Indeed, it seems but a long arm of the sea, the rise and fall of the tide being perceptible even at that distance. Night closes on the journey. During the time you pass through an expanse of the river twelve miles wide and eighteen miles long (Lake George), and when you awake you find the boat in a narrow stream, running beneath the shade of overhanging vines and palmettos, the waters bearing upon their surface a strange, floating, bright-green vegetation, well described by the popular name water-lettuce. Along the shore acres of broad-leaved water-lilies rise and fall with the rapidly-running waves, which surge along the course of the steamer. Here the stream is exceedingly tortuous, and the greatest care is needed on the part of the pilot lest, in turning the acute agles of low-lying land which project to the right and left like alternating narrow blades, his boat will shoot forward beyond his control and fasten itself amid the tangled boughs of a partially submerged forest. This is the paradise of the sportsman, the home of wild ducks and turkeys, and pelicans, and pink curlews.

At a distance of one hundred and ninety miles from Jacksonville another broad expanse of water is entered—Lake Monroe—five miles wide and twelve miles long. On the shore of this lake the boat lands at Sanford, Orange County, which is the head of navigation for large steamers. Beyond this lake the river again diminishes in depth, and is navigable only for very light-draught boats. The origin of the river is in Lake Washington, amid the marshes of the Everglades, two hundred and fourteen miles farther to the south.

There are but few places on the course of the river that are desirable for invalids, on account of the proximity of swamps and danger from malaria. At Sanford I was somewhat amused to see the proprietor of a prominent hotel, which solicits the patronage of invalids, taken with a severe chill while at the desk receiving his guests.

The best places on the river are Magnolia and Green Cove Spring, twenty-eight and thirty miles south of Jacksonville, and Palatka, seventy-five miles from there, each of which possesses superior hotel accommodations, and is subject but little, if at all, to malaria during the winter season.

Gainesville, some forty miles west of Palatka on the line of the Transit Railway, is one of the best locations in the State. It is situated on comparatively high land for Florida, is surrounded by pine-woods, and free from malaria—but, other than as a health resort, has no attractions.

Jacksonville, the center of trade activity, eighteen miles from the mouth of the St. John's, is a city of considerable enterprise. The comforts and conveniences of a Northern city can be obtained there in greater degree than anywhere else in the State. It has, however, in addition, some of the injurious influences which pertain to large cities. There is more danger of typho-malarial diseases and intestinal troubles.

St. Augustine—twenty-five miles south of the mouth of the St. John's, on the coast—that old Spanish town which rests so tranquilly by the sea, looking out over the broad waves of the Atlantic, which roll across from the mother-land, is a most interesting place to the voyager. Its quaint houses, built in the Spanish fashion, from the coquina or imperfectly-formed limestone which is quarried on the beach ; its narrow and winding streets, which one may almost cross with a single stride ; its old fort, dating from 1696, when Spanish power still ruled a large portion of the world, and Florida was one of the least of its possessions—these, and the many legends which linger around the only moss-covered ruins in America, are the attractions of the place. Long before Jacksonville or any settlement on the St. John's River existed, St. Augustine was noted for its salubrious climate. It is now known, however, that its exposed position on the coast, subjecting it to the whims of every wild northeaster, make it unfitted for very sensitive invalids, though still a favorite resort for several wealthy New York gentlemen of yachting proclivities, who have villas there—and also for those of youthful fervor who cling to romance and sentiment.

A SOUTH AFRICAN ARCADIA.*

By C. G. BÜTTNER.

THE traveler, coming fresh from Europe into Damaraland, is struck by the complete communistic freedom with which every man appropriates the land and its natural products. Roads have been worn

* Translated for "The Popular Science Monthly" from "Das Ausland."

through the thickets by foot-men and the heavy ox-wagons, and the chief villages are connected by a kind of highway, but no one is obliged to keep the roads if he does not want to. They are of no more significance than the zebra or rhinoceros tracks which led to the drinking-places before man appeared in the country ; and there is no reason why the traveler should not make a new road at pleasure. The pasturage is free for the teamster's hungry cattle, the wood for the fire needed to cook his supper. If a stray spark sets the grass on fire, no one thinks of complaining ; if a hunter commits devastation among the game, the native may grumble at the waste, but he will not imagine that his rights are trespassed upon, or venture to interfere with the proceedings. The game is as much the strange hunter's as his. If one sees a spot that pleases him, he is at liberty to settle upon it, and build himself a house there. If any objection is made to the stranger, nothing worse happens than that something unreasonable is demanded of him, in the same way that people in other parts of the world are not ashamed to overreach strangers : this is not so easily done, however, if the intruder is a native or a member of the same tribe ; and even a stranger, if he does not allow himself to be scared away, is at last permitted to remain undisturbed. Whoever settles in any particular spot must, however, expect that other persons, finding it well supplied with water and pasturage, will bring their herds there too ; and it is the practice of the Herero, when they wish to get rid of an unwelcome neighbor, notwithstanding their communism, to bring up so many herds and establish so many cattle-ranges about his house that he becomes disgusted with the frequent intrusions, and is obliged to go away from the exhausted tract. Some of the Herero chiefs have recently begun to drive single settlers away by force, but they are actuated by ulterior political views. The people are not disposed to grudge a stranger the particular spot of land he occupies, but they wish to drive foreigners out of the country altogether. An incident from Damara history will help to illustrate the extent to which this sense of communism goes. When the Hereros had succeeded, after nine years of warfare, in shaking off the domination of the Namaquas, to whom they had previously been subjected, the Namaqua chief, Jan Afrikaner, asked the missionaries to help him make a peace with them. The missionaries proposed that the two parties should fix a boundary between themselves, which they would both respect. Both refused to do this. They were ready to make a peace, they said, and keep it, but they would have the land, over which they had fought so hard, in common. The Herero chief, Kamaherero, declared repeatedly that Jan might live in any part of the land he chose after the peace, and that he should expect a fair proportion of his own people to be allowed to live in Jan's land. The peace contracted on these terms lasted fully ten years.

The custom is the same with regard to that which the earth conceals: every one takes of its treasures wherever he finds them. All, from all directions, fetch iron and copper ores from those parts of the land where the mines have been known to exist from time immemorial; and the people who ordinarily live near the mines have never on that account thought of assuming any right of proprietorship over them. There are but few salt-licks in the land; and, as soon after the rainy season as the ground becomes passable, the herders from all quarters drive their cattle across the pasture-lands indifferently to the springs. The dwellers around these places look on quietly, while the cattle and the sheep, flocking up by thousands from all the regions around, tread down and destroy the grass of their pastures. They may complain to themselves about the destruction, but it never occurs to them to drive the strangers away. It would be decidedly foreign to the Damara mind for any one to undertake, as Europeans are accustomed to do, to monopolize the salt-springs and charge a higher price for the use of them as they become more indispensable to others.

The Hereros will even resist, in every way, any one conceding, by sale, a particular right to any person to hold any piece of land. The Roman Catholic missionaries, who recently sought to gain a footing in Damaraland, made themselves suspected more than in any other way by representing to the people that they would do better by them than the Protestant missionaries had done, for they would buy land for their churches, schools, and dwellings, while the Protestant missionaries were occupying land for those purposes free. They ruined their cause, and prompted the heathen chief to try every device to get them away. In a similar manner, the chiefs told us German missionaries, whenever the subject came up, "You may live in our country as long as you wish, and no one shall molest you so long as the land belongs to us, but we will not sell a bit of it to any man."

There are not even any real boundaries between the different tribes. Some of the chiefs have, indeed, set up exclusive claims to particular tracts, but have never assumed to enforce them; and other tribes have never been required to leave the land. The natural result of this communism is, that no one has a personal care for the land, but gets all he can out of it, and then leaves it waste to go to a new spot. Hence the language of the Hereros has no terms for home, fatherland, or boundary-lines.

This communism extends to all the productions of the earth that have not been separated from it. Whatever a man has put his hand upon, that becomes his private property. Whoever takes from a man anything that he has appropriated to his own use, is a thief. Game, free in the fields, belongs to whoever can kill it; but to take it away from a hunter who has bagged it is a theft, or robbery. In Damara law even game which has only been hit, and has afterward been killed by some one else, belongs to the hunter who first hit it, although he is expected to give a share of it to the other one. This feeling is so strong that, when shooting-parties are made up, the right to the first shot passes from one to another by turns, so that it may be possible for each one to get a piece of game. The hunter who has to make the first shot is in that case the real hunter, and the others are only his helpers ; but, if he misses, the right passes over to the next one.

Any one can cut down a tree who wishes to, but another is not allowed to appropriate the wood after it has been taken possession of. Any one may dig a well for his cattle wherever there is hope of finding water, but no one can drink out of the well which another has dug without the permission of the owner. The lord of the well, when he is asked for water, will generally order his people to wait upon the one making the request, so that he does not get paid for the water, but for the attendance ; and, if he does not choose to permit the well to be used for another man's cattle, the argument that he did not create the water has no effect upon him. When any one finds a piece of land suitable for a garden, he can fence it and till it, and the crop will belong to him ; and it is generally considered wrong for any one to enter upon land that has been put under cultivation by another and till it for himself. But it would be contrary to custom, and provoke resistance, if any one, leaving the place and abandoning his garden, should attempt to sell any right in it. The tract again becomes free for the first comer to occupy.

A kind of property in personal goods is theoretically recognized, but the right is, in practice, one that rather appertains to the family than to the individual. A general principle seems to prevail that it is not right to refuse a gift to one who asks it, particularly if he is a relative or a friend, or is powerful or rich. People of this class have no hesitation in begging, and the stranger may be sure that the ragged fellow who asks him for a new shirt in place of his worn-out one is a person of wealth who thinks he is doing him honor, and is according him the recognition he would give to his lord or his father. The denial of the first request does not generally give offense ; but, if the request is granted, the asker will demand more and greater things, and will expect to get them ; and, if a person gives to one of a number of beggars, he must give to all the rest, or they will think he is dishonoring them.

The people, however, exercise without scruple the right to appropriate their relative's goods to their own use, if he is not there to prevent it ; and this state of public opinion leads to some comical scenes. A wealthy old chief, who had hundreds of dependents, possessed numerous articles of European clothing, without owning a complete suit ; but, whenever he went out, he had to put his clothes all on, however hot the weather. He came to me to be photographed one day, having on a pair of shoes, three pairs of thick moleskin trousers, a waistcoat over an indefinite number of shirts, a large shawl around his body, a thick jacket, a shawl around his neck, with a large dressing-gown over the whole; and on his head a kerchief, a Calabrian cap, and a velvet cap with pearl ornaments; and all this in a heat in which his aboriginal nakedness would have been much more comfortable—because he was afraid, if he left the garments at home, the members of his household would appropriate them. This same chief asked one of my friends for a piece of soap, so that he could wash his clothes himself; for he was afraid, if he gave them to any one else to wash, they would not be returned. If the clothes are locked up in a trunk they will be safe, for it is considered stealing to take them when they are thus secured; but, if the trunk is left open, Damara custom permits the clothes to be lifted carefully out and put one side, and the trunk to be carried off. Articles of personal property may, however, be devoted to special uses, or to special persons, by a kind of form of consecration, when the right to them is respected. A custom of this kind has prevailed from antiquity with reference to cattle and milk-vessels. Frequently, also, the head of the house has the right to the first use of things; among the Hottentots they are his so long as they are whole, but as soon as they are damaged the relatives are at liberty to get them if they can.

New milk must be taken to the master to taste before the rest can partake of it; and this imposes no small labor on the lord of a thousand milch-cows. Likewise whatever is killed must be brought to him first. If he is not at home, the ancestral staff represents him, and must be dipped into the milk or touch the meat. Particular animals are sometimes milked for each member of the family, into a vessel set apart for him, and then it is wrong for any one to touch the dish without the owner's permission. The master's dish is filled even when he is absent, and must not be used by any one else under penalty of bad luck; but, when it is needed for the next milking, the milk already in it is poured out on the ground. If, however, a visitor comes to the place, he, as the master's guest, can use his dish and drink his share of the milk without impropriety. After the owner of the cow and the vessel is dead, the vessel is still regularly filled and emptied, unless some guest comes along to whom the contents can be given.

The principal property of the Herero consists in cattle. As the lambs and calves and the mother-cows are never slaughtered, and other animals only on festal occasions, the herds increase very rapidly in the warm climate of the country, and require constantly larger pasturage tracts. This leads to frequent interferences, with occasions for contention; and at intervals the pasturage becomes exhausted, and great suffering ensues. The Hereros are thus exposed to periodical alternations of wealth and poverty.

The chiefs have, however, a tolerably secure possession in their retainers; and the feudal and patriarchal relation in which the men stand to each other is in strong contrast with the community of title to the land and soil. Theoretically, the function of head of the family descends to the eldest son; practically, it is exercised by the strongest member of the family—who is most likely an uncle of the heir—around whom the other members group themselves as dependents. The position of the women is not essentially different from that of the women of the working-classes in Europe. The work is divided between the two sexes about as it is in Europe, and the women are not called upon to do men's work, except in case of need, while the men are willing enough to help in the peculiar women's work whenever they can make themselves useful and have nothing better to do, provided no strangers are in sight. Polygamy is freely allowed, and as many alliances as possible are formed by the head of the family, as a means of strengthening his influence and conciliating his neighbors and rivals. The provisions of matrimonial alliances are carefully considered and guarded, so that each family may receive all the honor it is entitled to, and neither shall get the advantage of the other. Slavery exists in a mild form, but the sale of slaves seldom occurs. Children are taken into the council of their parents, and are consulted about important matters from a very early age; and the parent will seldom disregard the advice of his child, or exercise constraint upon him in any matter except indirectly and in the most gentle way.

The most wealthy cattle-owners number their herds by the thousand head. It is impossible to keep them all in one place, and they are therefore distributed at different stations under the charge of particular herdsmen. The herdsman's position is a considerable one, and brings with it privileges enough to make it desirable. The cattle are not distinguished by any specific marks, and the owner's only means of recognizing them is by his personal acquaintance with them. This requires him to be continually on the watch, and to go frequently the round of the stations to inspect them, else his herdsmen might make some of them their own. Most owners become extremely skillful in noticing and recognizing the individual peculiarities of their animals.

The system of inheritance is determined by the circumstances of the country and its customs, which require that the head of the family must be strong and wise enough to maintain his rights. By its operation, when a chief dies and leaves a family of minors, his whole personal estate goes, not to his widow and children, but to the nearest man of might in the family. The cattle and servants become his, and the widow and children become his wife and children, the latter on an equal footing with his own children, so precisely that the language of the country has no word for step-father and step-child. One of the results of the system is that the rich and powerful grow more wealthy and influential the longer they live, while the children and younger members of the family receive nothing as of right. It has, however, become customary for the children to be given particular animals as their own, their right to which, with the increase, is regularly and formally recognized; and with these and what additions to their stock they may acquire in one way or another, they are able gradually to accumulate a considerable property as they grow up.

The wealth of a man who has grown fat in riches may consist in what he has inherited from his father, or from the chief of his family; in what he has received from more distant relatives; in what he has gained in fees from his herdsmen; and in what of the property of other estates he has received by becoming the head of the family. The line of descent of all this property, which consists almost wholly of the pedigrees of the cattle, is carefully preserved, and the accumulations of each kind can be as carefully computed and allotted as is done in the case of the accounts of European bankers. When the lord dies, all this property, with its increase, must go where it came from. The division, or the fact that it is to take place, brings all the connections of the family from far and wide around the bed of the lord when he has died or is expected to die, for each claimant must be present in person to assert his claim, or it will be overlooked or overpowered. The herdsmen must likewise bring up all the cattle from the various stations, that they may be identified according to their pedigrees. The division of all these animals and the adjudication of the claims of all the pretendants who appear, sometimes consumes months of time, with discussions which are often carried on in the midst of great excitement. The dying man may himself give directions respecting the division of his property, which are then implicitly carried out, otherwise the man who disregards them may be troubled by his ghost.

PIRATICAL PUBLISHERS.

By LEONARD SCOTT.

THE republishers of foreign books and periodicals at cheap rates have long and meekly borne the name which heads this article. I propose to show that they do not also deserve it.

Piracy is robbery in its boldest form, having no warrant but the strength of the bloody hand that commits it. It is against all law and all right, human or divine. It has no sanction nor show of sanction from the practice of others recognized, in all the walks of life, as respectable and honored citizens.

Will this description apply to the reprinting of foreign books? Certainly not. What, then, is the crime of which republishers are guilty? Their calumniators will answer, "Oh! they rob the foreign author of the product of his brain." Let us see if this is true. I grant that if all the nations of the earth had one common interest and one common government to support it, so that legislation should always be for the mutual advantage of *all* the inhabitants—the same in one section as in another—then the reprinting of a book by or for any one but its author would be a violation of right; but as this Utopia does not and never will exist, we must deal with men, and governments, and their selfishness as we find them. Nations legislate for what they believe to be to their own advantage, and without regard to the interests of their neighbors. Thus, England manufactures goods, and the manufacturer claims that he has a natural right freely to offer these goods as cheaply in one part of the world as in another, save only the cost of conveyance. But do other countries recognize such right? Does this country, for instance, acknowledge it when she lays a heavy duty upon such manufactures? When such duty is so great as to prohibit the importation of a manufactured article that would, if free of duty, sell largely in the United States, is not the manufacturer as effectually robbed as the author whose sales are rendered impossible by a reprint of his book?

Doubtless I shall be told that the cases are not parallel, inasmuch as in the one case the Government of the United States commits the trespass, and in the other its private citizens. I confess I see no difference. Government represents and legislates for its private citizens. Its tariff for revenue furnishes the means which would otherwise have to be taken by direct taxation from the pockets of the people. Its tariff for protection gives encouragement to native manufacturers; the whole system of levying duties upon foreign merchandise is one of pure selfishness, and as much a robbery or piracy of the natural rights of the foreigner as anything yet done by an American republisher. Suppose there were no such market for English books as the United States now offers, would English publishers any the less continue to print them? These works are produced mainly for the markets of Great Britain and its English-speaking dependencies. The withholding of an international copyright law does not take away from them what they never possessed or had any right to claim. The American republisher, therefore, in the absence of such a law, buys the English book at the English price, and thinks he has done all that is required of him to become its absolute owner, to do with it whatever the laws of his country do not forbid. Who shall say that among these rights is not the right to reprint it? "But," say the advocates of copyright, "*inventors* are protected by international *patent-right*, and, if the product of the inventor's brain is entitled to protection, that of the author's is no less so." Here, however, self-interest is again clearly indicated. There was a time when international patent-right did not exist between the United States and Great Britain; but when it became notorious that the inventions of Americans were more numerous and more valuable than those of other countries, our Government willingly consented to international patent-right, and I venture to say that, when American books shall be as popular in England as English books are in the United States, copyright will no longer be withheld.

It will doubtless be urged that I am placing our government in an unenviable light; that selfishness and not right rules its conduct. I answer that all governments, under like conditions, would pursue a similar course. Great Britain may arrogate to herself national liberality for having opened her ports, with little or no restriction, to the commerce of the world; but the motives which prompted such liberality were as purely selfish as were those of the United States in fettering commerce by her high tariff. Great Britain, assured of her supremacy as the great manufacturer of the world, did not fear the competition of other manufacturers, whether protected or not; and she became, at once, the advocate and the exemplar of free trade, believing that other nations would reciprocate, and thus give greater encouragement to the commerce in which, as a nation, her chief interest lies. Disappointed in her expectations that other countries would follow her example, she is now considering the policy of abandoning "free trade" for what she calls "fair trade," self-interest again prompting this change of attitude toward other nations; and yet she is not in reality any more selfish in the one case than in the other.

Referring again to what is called the *moral wrong* of using the product of another's brain without remuneration, I would ask, "Why this special claim of a foreign author?" Does not our government send experts abroad to gain information on subjects of the greatest importance to our interests at home? Do not these experts closely examine the establishments, public and private, of the Old World and gain all the information possible in regard to them? Do they not visit the great manufactories in all their variety; the workshops, the docks, war-vessels, arsenals, colleges, schools, prisons, hospitals, and churches; and inquire into and observe the modes of foreign life, social, industrial, political, and religious? In short, do they not inform themselves of everything likely to be of benefit to their own country, and, although the information given them may have been the result of centuries of brain-labor, do their countrymen hesitate to appropriate such information to their own use and without pay? The fact is that, the intercommunication of nations gives advantages which isolation could not afford, and if such advantages include the spread of knowledge among the people, obtained either in the way I have here described, or by the cheap reprint of a foreign book, it would be difficult to show anything criminal in thus acquiring it.

In conclusion, it may be well to remark that, even in England, brain-property is not treated like that known as personal or real, for, while the latter has perpetual protection by law, the former has only protection within prescribed limits, the English copyright extending only for a certain number of years, and it is well known that many of the most valuable standard works, both in prose and poetry, are being continually republished in England without any remuneration to the authors or their heirs. If authors have an inherent right to the products of their brains, the lapse of time should be no reason for taking that right away, and English publishers are as morally guilty of robbery when they fail to make remuneration to such authors or their legal representatives, after the law no longer protects them, as are the American publishers who do the same with English copyright books for which there is no American protection. O most conscientious Briton! when thou doest unto others as thou wouldst that others should do unto thee, then mayst thou, with more consistency, indulge in the abuse of those whom thou delightest to call "piratical publishers."

A CHAPTER IN TRANSCENDENTAL PATHOLOGY.

IN his address to the Pathological Section of the British Medical Association, on the occasion of its meeting at Worcester this year, the distinguished president of the section, Dr. J. Hughlings-Jackson, threw out the suggestion that inflammation should be regarded as a process of dissolution. His meaning will be fully intelligible only to those who have some knowledge of the system of philosophy which Mr. Herbert Spencer has given to the world. It may be interesting, both to those who are familiar with Mr. Spencer's writings, and to those who are not, if we somewhat expand Dr. Jackson's hint, and inquire briefly how far inflammation corresponds to Mr. Spencer's definition of dissolution. If we find that it is included in that definition, it may enable us to trace relations between inflammation and other allied processes—mineral, vegetal, animal, psychological, and social—which can not but enlarge and make clearer our views of it and them.

Evolution, our readers will hardly need reminding, is the process of growth and life; *dissolution*, that of decay and death. The definition of inflammation which is given by one of the most eminent writers upon the subject starts from the proposition that inflammation is the result of injury. We should, therefore, *a priori*, expect that changes which are the result of injury would have their analogues rather in the processes of decay and death than in those of life and growth. The definition of evolution which Mr. Spencer formulates is as follows: "Evolution is an integration of matter and concomitant dissipation of motion, during which the matter passes from an indefinite, incoherent homogeneity to a definite, coherent heterogeneity, and during which the retained motion undergoes a parallel transformation."

Dissolution is the reverse of this. We have, then, to see if inflammation corresponds to a definition running thus: Dissolution is a disintegration of matter and concomitant absorption of motion, during which the matter passes from a definite, coherent heterogeneity to an indefinite, incoherent homogeneity, and during which the retained motion undergoes a parallel transformation.

The first thing which our definition asserts is, that inflammation is a disintegration of matter. This proposition needs little defense. Do we not find that inflamed parts are always softened, and that when the process is severe and continued they become liquefied, converted into pus? Inflammation clearly is a process which tends to the disintegration of matter. We learn, next, that the disintegration of matter is accompanied with concomitant absorption of motion. This, on consideration, will be found equally true, although, perhaps, not so obvious. In the process of evolution the motion of units (molecular motion) becomes converted into the motion of aggregates (molar motion); and in dissolution the reverse takes place. The latter we shall find hold good of inflammation. An inflamed part is not only softened—which means that its component molecules move more readily upon one another—but it is swollen. The particles previously integrated into a solid mass, occupying a small space, have most of them moved farther away from one another, and now occupy a comparatively great space. Besides this, it is hotter than natural, and heat is a mode of motion. There is thus an increase of molecular motion. With this, the functional activity of the part which, from our present point of view, is its motion as an aggregate (for all force is a mode of motion), is lessened. To take the most literal illustration: an inflamed muscle can not contract with the force of a healthy one. Seeing, then, that there is an increase of molecular motion in an inflamed part, we might be content with pointing out that this motion must have been obtained from somewhere. But we may go further. There is one remedy, the potency of which, in checking inflammatory change, can not be gainsaid. It can not everywhere be efficiently applied, and it is not always decidedly for the patient's benefit that inflammation should be too rudely cut short; but, when circumstances admit of cold being brought into play, there is no doubt that it will arrest or suspend inflammatory change. We find throughout the universe that cold everywhere arrests molecular motion. It makes fluids into solids, vapors into fluids; checks chemical as well as vital change. The inflamed part to which cold is applied is surrounded by a medium from which it can not absorb motion; and, if motion can not be absorbed, inflammation can not go on. Inflammation, then, is a change attended with the absorption of motion as well as with the disintegration of matter.

Proceeding with our definition, we find it next informs us that the matter (in the present case the inflamed part) passes from a definite, coherent heterogeneity to an indefinite, incoherent homogeneity. It is a general assertion that holds good of inflammation in every part of the body, that from the first stage to the last it tends to blend and confuse together, to destroy the distinctive features of the individual structures of the part affected. In the beginning we have infiltration with leucocytes, replacing with cells of indefinite type the muscular, nervous, fibrous, and other naturally well-defined elements of the part affected. Finally, we have every trace of the latter lost; the definiteness of structure, its coherence and heterogeneity have gone, and we have in place simply a collection of fluid homogeneous pus. The progress is clearly from the definite, the coherent, and the heterogeneous, to the indefinite, the incoherent, and the homogeneous. The last part of the definition asserts that the retained motion undergoes a like transformation. This we have partly touched on already. The healthy body contains structures which absorb, transform, and give out force—that is, motion—in different ways. By the intestinal canal, force stored up by plants and animals is taken into the body. By the lymphatic and vascular system it is transferred from the place where it is taken in to the place where it is wanted for use. By the nervous, muscular, and glandular apparatus it is converted into sensible motion of the organism as a whole, or into secretions capable of setting up various changes in the substances with which they come in contact, or of producing and nourishing a new being. We have, therefore, in the normal organism, motion given out in many heterogeneous forms, each form being definite, and each so related to the activity of the rest that the body forms a whole as coherent in function as it is in structure. When inflammation affects a part, these features of its dynamic activity disappear. Natural function is either lost, or performed only in an imperfect way. In place of the exertion of force in ways heterogeneous, but definite, we have the homogeneous molecular motion manifested by liquefaction, swelling, and warmth. Definiteness of function, as of structure, is lost; heterogeneity of tissue-changes, as of the tissues themselves, is altered to homogeneity; and in place of the part fulfilling its function to the advantage of every other part, that is, in a manner coherent with functional activity elsewhere, it exercises only a perturbing, injurious effect—its functional activity has become incoherent instead of coherent.

The subject is a very large one; and in the space that we are able to give to it we can not do more than imperfectly indicate the analogies which inflammatory changes bear to those of dissolution generally. If our remarks should incite others to follow up the subject in a more exact and comprehensive manner, our object in making them will have been amply fulfilled.—*Medical Times and Gazette.*

THE PEDIGREE OF WHEAT.

By Professor GRANT ALLEN.

WHEAT ranks by origin as a degenerate and degraded lily. Such in brief is the proposition which this paper sets out to prove, and which the whole course of evolutionary botany tends every day more and more fully to confirm. By thus from the very outset placing clearly before our eyes the goal of our argument, we shall be able the better to understand as we go whither each item of the cumulative evidence is really tending. We must endeavor to start with the simplest forms of the great group of plants to which the cereals and the other grasses belong, and we must try to see by what steps this primitive type gave birth, first to the brilliantly colored lilies, next to the degraded rushes and sedges, and then to the still more degenerate grasses, from one or other of whose richer grains man has finally developed his wheat, his rice, his millet, and his barley. We shall thus trace throughout the whole pedigree of wheat from the time when its ancestors first diverged from the common stock of the lilies and the water-plantains, to the time when savage man found it growing wild among the untilled plains of prehistoric Asia, and took it under his special protection in the little garden-plots around his wattled hut, whence it has gradually altered under his constant selection into the golden grain that now covers half the lowland tilth of Europe and America. There is no page in botanical history more full of genuine romance than this; and there is no page in which the evidence is clearer or more convincing for those who will take the easy trouble to read it aright.

The fixed point from which we start is the primitive and undifferentiated ancestral flowering plant. Into the previous history of the line from which the cereals are ultimately descended, I do not propose here to enter. It must suffice for our present purpose to say dogmatically that the flowering plants as a whole derive their origin from a still earlier flowerless stock, akin in many points to the ferns and the club-mosses, but differing from them in the relatively important part borne in its economy by the mechanism for cross-fertilization. The earliest flowering plant of the great monocotyledonous division (the only one with which we shall here have anything to do) started apparently by possessing a very simple and inconspicuous blossom, with a central row of three ovaries, surrounded by two or more rows of three stamens each, without any colored petals or other ornamental adjuncts of any sort. I need hardly explain even to the unbotanical reader at the present day that the ovaries contain the embryo seeds, and that they only swell into fertile fruits after they have been duly impregnated by pollen from the stamens, preferably those of another plant, or at least of another blossom on the same stem. Seeds fertilized by pollen from their own flower, as Mr. Darwin has shown, produce relatively weak and sickly seedlings; seeds fertilized by pollen from a sister plant of the same species produce relatively strong and hearty seedlings. The two cases are exactly analogous to the effects of breeding in and in or of an infusion of fresh blood among races of men and animals. Hence it naturally happens that those plants whose organization in any way favors the ready transference of pollen from one flower to another gain an advantage in the struggle for existence, and so tend on the average to thrive and to survive; while those plants whose organization renders such transference difficult or impossible stand at a constant disadvantage in the race for life, and are liable to fall behind in the contest, or at least to survive only in the most unfavorable and least occupied parts of the vegetal economy. Familiar as this principle has now become to all scientific biologists, it is yet so absolutely necessary for the comprehension of the present question, whose key-note it forms, that I shall make no apology for thus once more stating it at the outset as the general law which must guide us through all the intricacies of the development of wheat.

Our primitive ancestral lily, not yet a lily or anything else namable in our existing terms, had thus, to start with, one triple set of ovaries, and about three triple sets of pollen-bearing stamens; and to the very end this triple arrangement may be traced under more or less difficult disguises in every one of its numerous modern descendants. No single survivor, however, now represents for us this earliest ideal stage; we can only infer its existence from the diverse forms assumed by its various divergent modifications at the present day, all of which show many signs of being ultimately derived from some such primordial and simple ancestor. The first step in advance consisted in the acquisition of petals, which are now possessed in a more or less rudimentary shape by all the tribe of trinary flowers, or at least, if quite absent, are shown to have been once present by intermediate links or by abortive rudiments. There are even now flowers of this class which do not at present possess any observable petals at all; but these can be shown (as we shall see hereafter) not to be unaltered descendants of the prime type, but on the contrary to be very degraded and profoundly modified forms, derived from later petal-bearing ancestors, and still connected with their petal-bearing allies by all stages of intervening degeneracy. The original petalless lily has long since died out before the fierce competition of its own more advanced descendants; and the existing petalless reeds or cuckoo-pints, as well as the apparently petalless wheats and grasses, are special adaptive forms of the newer petal-bearing rushes and lilies.

The origin of the colored petals is almost certainly due to the selective action of primeval insects. The soft pollen, and perhaps, too, the slight natural exudations around the early flowers, afforded food to the ancestral creatures not then fully developed into anything that we could distinctively call a bee or a butterfly. But, as the insects flew about from one head to another in search of such food, they carried small quantities of pollen with them from flower to flower. This pollen, brushed from their bodies on to the sensitive surface of the ovaries, fertilized the embryo seeds, and so gave the fortunate plants which happened to attract the insects all the benefits of a salutary cross. Accordingly, the more the flowers succeeded in attracting the eyes of their winged guests, the better were they likely to succeed in the struggle for existence. In some cases, the outer row of stamens appears to have become flattened and petal-like, as still often happens with plants in the rich soil of our gardens; and in these flatter stamens the oxidized juices assumed perhaps a livelier yellow than even the central stamens themselves. If the flowers had fertilized their own ovaries this change would of course have proved disadvantageous, by depriving them entirely of the services of one row of stamens; for the new flattened and petal-like structures lost at once the habit of producing pollen. But their value as attractive organs for alluring the eyes of insects more than counterbalanced this slight apparent disadvantage; and the new petal-bearing blossoms soon outstripped and utterly lived down all their simpler petalless allies. By devoting one outer row of stamens to the function of alluring the fertilizing flies, they have secured the great benefit of perpetual cross-fertilization, and so have got the better of all their less developed competitors. At the same time, the exudations at the base of the petals have assumed the definite form of sweet nectar or honey, a liquid which is mainly composed of sugar, that universal allurer of animal tastes. By this means the plants save their pollen from depredations, and at the same time offer the insects a more effectual, because a more palatable, sort of bribe.

Passing rapidly over these already familiar initial stages, we may go on to those more special and distinctive facts which peculiarly concern the ancestry of the lilies and cereals. It is probable that the nearest modern analogue of the earliest petal-bearing trinary flowers is to be found in the existing alisma tribe, including our own English arrowheads and flowering rushes. As a rule, indeed, it may be said that fresh-water plants and animals tend to preserve for us very ancient types indeed; and all the alismas are marsh or pond flowers of an extremely simple character. They have usually three greenish sepals outside each blossom, inclosing one whorl of three white or pink petals, two or three whorls of three stamens each, and a number of separate ovaries, which are not united, as in the more developed true lilies, into a single capsule, but remain quite distinct, each with its own individual stigma or sensitive surface. Even within this relatively early and simple group, however, several gradations of development may yet be traced. I incline to believe that our English smaller alisma, a not un-common plant in wet ditches and marshes throughout the whole of Southern Britain, represents the very earliest petal-bearing type in this line of development; indeed, save that its petals are now pinky-white, while those of the original ancestor were almost certainly yellow, we might almost say that the marsh-weed in question was really the earliest petal-bearing plant of which we are in search. It closely resembles in appearance, and in the arrangement of its parts, the buttercups, which are the earliest existing members of the other or quinary division of flowering plants; and in both we seem to get a survival of a still earlier common ancestor, only that in the one the parts are arranged in rows of three, while in the other they are arranged in rows of five; and concomitantly with this distinction go the two or three other distinctions which mark off the two main classes from one another—namely, that the one has leaves with parallel veins, only one seed-leaf to the embryo, and an endogenous stem, while the other has leaves with netted veins, two seed-leaves to the embryo, and an exogenous stem. Nevertheless, in spite of such fundamental differences, we may say that the alismas and the buttercups really stand very close to one another in the order of development. When the two main branches of flowering plants first diverged from one another, the earliest petal-bearing form they produced on one divergent branch was the alisma, or something very like it; the earliest petal-bearing form they produced on the other divergent branch was the buttercup, or something very like it. Hence, whenever we have to deal with the pedigree of either great line, the fixed historical point from which we must needs set out must always be the typical alismas or the typical buttercups. The accompanying diagram will show at once the relation of parts in the simplest trinary flowers, and will serve for comparison at a later stage of our argument with the arrangement of their degraded descendants, the wheats and grasses.

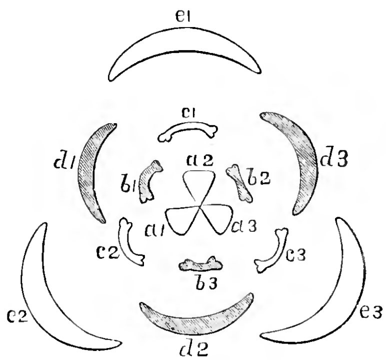

FIG. 1.—*a*, ovaries; *b*, stamens, inner whorl; *c*, stamens, outer whorl; *d*, petals; *e*, calyx-pieces.

Our own smaller alisma has a number of ovaries loosely scattered about in its center, as in the buttercups, with two rows of three stamens outside them, and then a single row of three petals, followed by the calyx or inclosing cup of three green pieces. Its close ally the water-plantain, however, shows signs of some advance toward the typical lily form in the arrangement of its ovaries in a single ring, often loosely divisible into three sets. And in the pretty pink flowering rush (not of course a rush at all in the scientific sense) the advance is still more marked in that the number of ovaries is reduced to six, that is to say, two whorls of three each, accompanied by nine stamens, similarly divisible into three rows. In all these very early forms (as in their analogues the buttercups) the main point to notice is this, that there is as yet no regular definiteness in the numerical relations of the parts. They tend to run, it is true, in rows of three; but often these rows are so numerous and so confused that nature loses count, so to speak, and it is only in their higher and more developed members that we begin to arrive at any distinct symmetry, such as that of the flowering rush. Even here, the symmetry is far from being so perfect as in the later lilies. There are, however, a few very special members of the alisma family in which the approach to the true lilies is even greater. These are well represented in England by our own common arrowgrasses—inconspicuous little green flowers, with three calyx-pieces, three petals, six stamens, and either six or three ovaries. Here, too, the ovaries are at first united into a single pistil (as it is technically called), though they afterward separate as they ripen into three or six distinct little capsules. One of our British kinds, the marsh arrowgrass, has almost reached the lily stage of development; for it has three calyx-pieces, three petals, six stamens, and three ovaries, exactly like the true lilies; but it falls short of their full type in the fact that its pistil divides when ripe into separate capsules, whereas the pistil of the lilies always remains united to the very end; and this minute difference suffices, in the eyes of systematic botanists, to make it an alisma rather than a lily. In reality, it ought to be regarded as a benevolent neutral—a surviving intermediate link between the two larger classes.

The specialization which makes the true lilies thus depends upon two points. In the first place, all the parts are regularly symmetrical, except that there are two rows of stamens to each one of the other organs: the common formula being three calyx-pieces, three petals, six stamens, and three ovaries. In the second place, the three ovaries are completely combined together into a single three-celled pistil. The advantage which the lilies thus gain is obvious enough. Their bright petals, usually larger and more attractive than those of the alismas, allure a sufficient number of insects to enable them to dispense with the numerous stamens and ovaries of their primitive ancestors. Moreover, this diminution in number is accompanied by an increase in effectiveness and specialization: for the lilies have only three sensitive surfaces to their pistil, combined on a single stalk; and the honey is usually so placed at its base that the insect can not fail to brush off pollen at every visit against all three surfaces at once. Again, while the number of ovaries has been lessened, the number of seeds in each has been generally increased, which also marks a step in advance, since it allows many seeds to be impregnated by a single act of pollination. The result of all these improvements, carried further by some lilies than by others, is that the family has absolutely outstripped all others of the trinary class in the race for the possession of the earth, and has now occupied all the most favorable positions in every part of the world. While the alismas and their allies have been so crowded out that they now linger only in a few ponds, marshes, and swamps, to which the more recent lily tribe have not yet had time fully to adapt themselves, the true lilies and their yet more advanced descendants have taken seizin of every climate and every zone upon our planet, and are to be found in every possible position, from the arborescent yuccas and huge agaves of the tropics to the wild hyacinths of our English woodlands and the graceful asphodels of the Mediterranean hill-sides.

The lilies themselves, again, do not all stand on one plane of homogeneous evolution. There are different grades of development still surviving among the class itself. The little yellow gagea which grows sparingly in sandy English fields may be taken as a very fair representative of the simplest and earliest true lily type. It bears a small bunch of little golden flowers, only to be distinguished from the higher alismas by their united ovaries: for though both calyx and petals are here brightly colored, that is also the case in the flowering rushes, and in many others of the alisma group. On the other hand, though it may be said generally of the lilies that their calyx and petals are colored alike—sometimes so much so as to be practically indistinguishable—yet there are many kinds which still retain the greenish calyx-pieces, and that even in the more developed genera. But most of the lilies are far handsomer than gagea and its allies: even in England itself we have such very conspicuous and attractive flowers as the purple fritillaries, which every Oxford man has gathered by handfuls in the spongy meadows about Iffley lock, with their dark spotted petals converging into a bell, and the nectaries at the base producing each a large drop of luscious honey. Some, like our wild hyacinths, have assumed a tubular shape under stress of insect selection, the better to promote proper fertilization; and at the same time have acquired a blue pigment, to allure the eyes of azure-loving bees. Others have become dappled with spots to act as honey-guides, or have produced brilliant variegated blossoms to attract the attention of great tropical insects. Our British lilies alone comprise such various examples as the lily-of-the-valley, a tubular, white, scented species, adapted for fertilization by moths; the very similar Solomon's-seal; the butcher's-broom; the wild tulip; the star-of-Bethlehem; the various squills; the asparagus; the grape-hyacinth; and the meadow-saffron. Some of them (for example, asparagus and butcher's-broom) have also developed berries in place of dry capsules; and these berries, being eaten by birds which digest the pulp, but not the actual seeds, aid in the dispersion of the seedlings, and so enable the plant to reduce the total number of seeds to three only, or one in each ovary. Among familiar exotics of the same family may be mentioned the hyacinth, tuberose, tulip, asphodel, yucca, and most of the so-called lilies. In short, no tribe supplies us with a greater number of handsome garden flowers, for the most part highly adapted to a very advanced type of insect fertilization.

Properly to understand the development of our existing wheat from this brilliant and ornamental family, as well as to realize the true nature of its relation to allied orders, we must first glance briefly at the upward evolution of the other branches descended from the true lilies, and then recur to the downward evolution which finally resulted in the production of the degenerate grasses. In the main line of progressive development, the lilies gave origin to the amaryllids, familiarly represented in England by the snow-drops and daffodils, a family which is technically described as differing from the lilies in having an inferior instead of a superior ovary—that is to say, with the pistil apparently placed below instead of above the point where the petals and calyx-pieces are inserted. From the evolutionary point of view, however, this difference merely amounts to saying that the amaryllids are tubular lilies, in which the tube has coalesced with the walls of the ovary, so that the petals seem to begin at its summit instead of at its base. The change gives still greater certainty of impregnation, and therefore benefits the race accordingly. At the same time, the amaryllids, being probably a much newer development than the true lilies, have not yet had leisure to gain quite so firm a footing in the world ; though on the other hand many of them are far more minutely adapted for special insect fertilization than their earlier allies. They include the so-called Guernsey lilies of our gardens, as well as the huge American aloes which all visitors to the Riviera know so well on the dry hills around Nice and Cannes. The iris family are a similar but rather more advanced tribe, with only three stamens instead of six, their superior organization allowing them readily to dispense with half their complement, and so to attain the perfect trinary symmetry of three sepals, three petals, three stamens, and three ovaries. Among them, the iris and the crocus are circular in shape, but some very advanced types, such as the gladiolus, have acquired a bilateral form, in correlation with special insect visits. From these, the step is not great to the orchids, undoubtedly the highest of all the trinary flowers, with the triple arrangement almost entirely obscured, and with the most extraordinary varieties of adaptation to fertilization by bees or even by humming-birds in the most marvelous fashions. Alike by their inferior ovary, their bilateral shape, their single stamen, their remarkable forms, their brilliant colors, and their occasional mimicry of insect-life, the orchids show themselves to be by far the highest of the trinary flowers, if not, indeed, of the entire vegetable world.

From this brief sketch of the main line of upward evolution from lilies to orchids, we must now return to the grand junction afforded us by the lilies themselves, and travel down the other line of degeneracy and degradation which leads us on to the grasses and the cereals, including at last our own familiar cultivated wheat. Any trinary flower with three calyx-pieces, three petals, six stamens, and a three-celled pistil not concealed within an inclosing tube, is said to be a lily, as long as it possesses brightly colored and delicate petals. There are, however, a large number of somewhat specialized lilies with very small and inconspicuous petals, which have been artificially separated by botanists as the rush family, not because they were really different in any important point of structure from the acknowledged lilies, but merely because they had not got such brilliant and handsome blossoms. These despised and neglected plants, however, supply us with the first downward step on the path of degeneracy which leads at last to the grasses, and they may be considered as intermediate stages in the scale of degradation, fortunately preserved for us by exceptional circumstances to the present day. Even among the true lilies, there are some, like the garlic and onion tribe, which show considerable marks of degeneration, owing to some decline from the type of insect fertilization to the undesirable habit of fertilizing themselves. Thus, while our common English rampsons or wild garlic has pretty and conspicuous white blossoms, some other members of the tribe, such as the crow allium, have very small greenish flowers, often reduced to mere shapeless bulbs. Among the true rushes, however, the course of development has been somewhat different. These water-weeds have acquired the habit of trusting for fertilization to the wind, which carries the pollen of one blossom to the sensitive surface of another, perhaps at less trouble and expense to the parent plant than would be necessary for the allurement of bees or flies by all the bribes of brilliant petals and honeyed secretions. To effect this object, their stamens hang out pensile to the breeze, on long, slender filaments, so lightly poised that the merest breath of air amply suffices to dislodge the pollen : while the sensitive surface of the ovaries is prolonged into a branched and feathery process, seen under the microscope to be studded with adhesive glandular knobs, which readily catch and retain every golden grain of the fertilizing powder which may chance to be wafted toward them on the wings of the wind. Under such circumstances, the rush kind could only lose by possessing brightly colored and attractive petals, which would induce insects uselessly to plunder their precious stores : and so all those rushes which showed any tendency in that direction would soon be weeded out by natural selection ; while those which produced only dry and inconspicuous petals would become the parents of future generations, and would hand on their own peculiarities to their descendants after them. Thus the existing rushes are all plain little lilies with dry, brownish flowers, specially adapted to wind-fertilization alone.

Among the rushes themselves, again, there are various levels of retrogressive development—retrogressive, that is to say, if we regard the lily family as an absolute standard: for the various alterations undergone by the different flowers are themselves adaptive to their new condition, though that condition is itself decidedly lower than the one from which they started. The common rush and its immediate congeners resemble the lilies from which they spring in having several seeds in each of the three cells which compose their pistil. But there is an interesting group of small grass-like plants, known as wood-rushes, which combine all the technical characteristics of the true rushes with a general character extremely like that of the grasses. They have long, thin, grass-like blades in the place of leaves; and, what is still more important, as indicating an approach to the essentially one-seeded grass tribe, they have only three seeds in the flower, one to each cell of the capsule. These seeds are comparatively large, and are richly stored with food-stuffs for the supply of the young plantlet. One such richly supplied embryo is worth many little unsupported grains, since it stands a much better chance than they do of surviving in the struggle for existence. The wood-rushes may thus be regarded as some of the earliest plants among the great trinary class to adopt those tactics of storing gluten, starch, and other food-stuffs along with the embryo, which have given the cereals their acknowledged superiority as producers of human food. They are closely connected with the rushes, on the one hand, by sundry intermediate species which possess thin leaves instead of cylindrical, pithy blades; and they lead on to the grasses, on the other, by reason of their very grass-like foliage, and their reduced number of large, well-furnished, starchy seeds.

In another particular, the rush family supplies us with a useful hint in tracing out the pedigree of the grasses and cereals. Their flowers are, for the most part, crowded together in large tufts or heads, each containing a considerable number of minute separate blossoms. Even among the true lilies we find some cases of such crowding in the hyacinths and the squills, or, still better, in the onion and garlic tribe. But, with the wind-fertilized rushes, the grouping together of the flowers has important advantages, because it enables the pollen more easily to fix upon one or other of the sensitive surfaces, as the stalks sway backward and forward before a gentle breeze. Among yet more developed or degraded wind-fertilized plants, this crowding of the blossoms becomes even more conspicuous. A common American rush-like water-plant, known as eriocaulon, helps us to bridge over the gap between the rushes and such compound flowers as the sedges and grasses. Eriocaulon and its allies have always one seed only in each cell of the pistil; and they have also generally a very delicate corolla and calyx, of from four to six pieces, representing the original three sepals and three petals of the lilies and rushes. But their minute blossoms are closely crowded together in globular heads, the stamens and pistils being here divided in separate flowers, though both kinds of flowers are combined in each head. From an ancestral form not unlike this, but still more like the wood-rushes, we must get both our sedges and our grasses. And though the sedges themselves do not stand in the direct line of descent to wheat and the other cereals, they are yet so valuable as an illustration from their points of analogy and of difference that we must turn aside for a moment to examine the gradual course of their evolution.

The simplest and most primitive sedges now surviving, though very degenerate in type, yet retain some distinct traces of their derivation from earlier rush-like and lily-like ancestors. In the earliest existing type, known as scirpus, the calyx and petals, which were brightly colored in the lilies, and which were reduced to six brown scales in the rushes, have undergone a further degradation to the form of six small, dry bristles, which now merely remain as rudimentary relics of a once useful and beautiful structure. In some species of scirpus, too, the number of these bristles is reduced from six to four or three. There is still one whorl of three stamens, however; but the second whorl has disappeared; while the pistil now contains only one seed instead of three; though it still retains some trace of the original three cells in the fact that there are three sensitive surfaces, united together at their base into one stalk or style. Each such diminution in the number of seeds is always accompanied by an increase in the effectiveness of those which remain; the difference is just analogous to that between the myriad ill-provided eggs of the cod, whose young fry are for the most part snapped up as soon as hatched, and the two or three eggs of birds, which watch their brood with such tender care, or the single young of cows, horses, and elephants, which guard their calves or foals almost up to the age of full maturity. What the bird or the animal effects by constant feeding with worms or milk, the plant effects by storing its seed with assorted food-stuffs for the sprouting embryo.

In the more advanced or more degenerate sedges we get still further differentiation for the special function of wind-fertilization. Take as an example of these most developed types, on this line of development, the common English group of carices. In these the flowers have absolutely lost all trace of a perianth (that is to say, of the calyx and petals), for they do not possess even the six diminutive bristles which form the last relics of those organs in their allies, the scirpus group. Each flower is either male or female—that is to say, it consists of stamens or ovaries alone. The male flowers are represented by a single scale or bract, inclosing three stamens; and in some species even the stamens are reduced to a pair, so that all trace of the original trinary arrangement is absolutely lost. The female flowers are represented by a single ovary, inclosed in a sort of loose bag, which may perhaps be the final rudiment of a tubular, bell-shaped corolla like that of the hyacinth. This ovary contains a single seed, but its shape is often triangular, and it has usually three stigmas or sensitive surfaces, thus dimly pointing back to the three distinct cells of its lily-like ancestors, and the three separate ovaries of its still earlier alisma-like progenitors. In many species, however, even this last souvenir of the trinary type has been utterly obliterated, the ovary having only two stigmas, and assuming a flattened, two-sided shape. In all the carices the flowers are loosely arranged in compact spikes and spikelets, with their mobile stamens hanging out freely to the breeze, and their feathery stigmas prepared to catch the slightest grain of pollen which may happen to be wafted their way by any passing breath of air. The varieties in their arrangement, however, are almost as infinite among the different species as those of the grasses themselves ; sometimes the male and female flowers are produced on separate plants ; sometimes they grow in separate spikes on the same plant ; sometimes the same spike has male flowers at the top and female at the bottom ; sometimes the various flowers are mixed up with one another at top and bottom, a regular hotch-potch of higgledy-piggledy confusion. But all the sedges alike are very grass-like in their aspect, with thin blades by way of leaves, and blossoms on tall heads, as in the grasses. In fact, the two families are never accurately distinguished by any except technical botanists ; to the ordinary observer, they are all grasses together, without petty distinctions of genus and species. Like the grasses, too, the sedges are mostly plants of the open, wind-swept plains or marshy levels, where the facilities for wind-fertilization are greatest and most constantly present.*

And now, from this illustrative digression, let us hark back again to the junction-point of the rushes, whence alike the sedges and the grasses appear to diverge. In order to understand the nature of the steps by which the cereals have been developed from rush-like ancestors, it will be necessary to look shortly at the actual composition of the flower in grasses, which is the only part of their organism differing appreciably from the ordinary lily type. The blossoms of grasses, in their simplest form, consist of several little green florets, arranged in small clusters, known as spikelets, along a single common axis. Of this arrangement, the head of wheat itself offers a familiar and excellent example. If we pull to pieces one of the spikelets composing such a head, we find it to consist of four or five distinct florets. Omitting special features and unnecessary details, we may say that each floret is made up of two chaffy scales, known as pales, and representing the calyx, together with a pair of small white petals known as lodicules, three stamens, and an ovary with two feathery styles. Moreover, the two pales or calyx-pieces are not similar and symmet-

* The sedges are not, in all probability, a real natural family, but are a group of heterogeneous, degraded lilies, containing almost all those kinds in which the reduced florets are covered by a single conspicuous glume-like bract. It will be seen from the sequel that these bracts are not truly analogous to the glumes or outer paleæ of grasses.

rical, for the outer one is simple and convex, while the inner one is apparently double, being made up of two pieces rolled into one, and still possessing two green midribs, which show distinctly like ribs on its flat outer surface. Here, it will immediately be apparent, the traces of the original trinary arrangement are very slight indeed.

But when we come to inquire into the rationale and genesis of these curiously one-sided flowers, it is not difficult to see that they have been ultimately derived from trinary blossoms of the rush-like type. The first and most marked divergence from that type, for which the analogy of the sedges has already prepared us, is the reduction of the ovary to a single one-seeded cell, whose ripe, fruity form is known as a grain. At one time, we may feel pretty sure, there must have existed a group of nascent grasses, which only differed from the wood-rush genus in having a single-celled ovary instead of a three-celled pistil with one seed in each cell; and even the ovary of this primitive grass must have retained one mark of its trinary origin in its possession of three styles to its one grain, thus pointing back (as most sedges still do) to its earlier rush-like origin. That hypothetical form must have had three sepals, three petals, six stamens, and one three-styled ovary. But the peculiar shape of modern grass-flowers is clearly due to their very spiky arrangement along the edge of the axis. In the wood-rushes and the sedges, we see some approach to this condition; but in the grasses, the crowding is far more marked, and the one-sidedness has accordingly become far more conspicuous. Suppose we begin to crowd a number of wind-fertilized lily-like flowers along an axis in this manner, taking care that the stamens and the sensitive feathery styles are always turned outward to catch the breeze (for otherwise they will die out at once), what sort of result shall we finally get?

In the first place, the calyx, consisting of three pieces, will stand toward the crowded stem or axis in such a fashion that one piece will be free and exterior, while two pieces will be interior and next the stem, thus:

O

a a

a

Now, the effect of constant crushing in this direction will be that the two inner calyx-pieces will be slowly dwarfed, and will tend to coalesce with one another; and this is what has actually happened with the inner pale of wheat and of other grasses, though the midribs of the two originally separate pieces still show on the compound pale, like dark-green lines down its center. Thus, in the fully developed grasses, in place of a trinary calyx, we get two chaffy scales or pales, the outer one representing a single sepal, and the inner one, which has been dwarfed by pressure against the stem, representing two sepals rolled into one, with two midribs still remaining as evidence of their original distinctness.

Next, in the case of the petals, which alternate with the sepals of the calyx, the relation to the stem is exactly reversed; for we have here two petals free and exterior, with one interior petal crowded closely against the axis, thus:

O

a

a a

Here, then, the two external petals will be saved, exactly as the one external sepal was saved in the case of the calyx; and these two petals are represented by the very small white lodicules under the outer pale in our existing wheats and grasses. On the other hand, the inner petal, jammed in between the grain and the inner pale (with the stem at its back), has been utterly crushed out of existence, partly because of its very small size, partly because of its functional uselessness, and partly because it had no other part with which to coalesce, and so to save itself as the inner sepals had managed to do. Moreover, it must be remembered that the sepals do still perform a useful service in protecting the young flower before it opens, and in keeping out noxious insects during the kerning or swelling of the grain; whereas the lodicules or rudimentary petals are now apparently quite functionless; and so we may congratulate ourselves that they are there at all, to preserve for us the true ground-plan of the floral architecture in grasses. Indeed, they have not survived by any means in all grasses; among the smaller and more degraded kinds they are often wholly wanting, having been quite crushed out between the calyx and the grain. It is only the larger and more primitive types that still exhibit them in any great perfection. On the other hand, one group of very large exotic grasses, the bamboos, has three regular petals, thus clearly showing the descent of the family as a whole from rush-like ancestors, and also obviously suggesting that the obsolescence of the inner petal in the other grasses is due to their small size and their closely packed minute flowers.

Among the stamens, one-sidedness has not notably established itself, for in wind-fertilized plants they must necessarily hang out freely to the breeze, and therefore they do not get much crowded between the other parts. A few grasses still even retain their double row of stamens, having six to each floret; but most of them have only one whorl of three. In some of the lower and more degraded forms, however, even the stamens have lost their trinary order, and only two now survive. This is the case in our own very degenerate little sweet-vernal-grass, the plant which imparts its delicious fragrance to new-mown hay. But in the cereals and in most other large species the three stamens still remain in undiminished effectiveness to the present day.

Finally, we come to the most important part of all, the ovary. This part, alternating with the stamens, has the same arrangement of styles relatively to the axis as in the case of the petals; and it has undergone precisely the same sort of abortive distortion. The two outer styles, hanging freely out of the calyx, have been preserved like the two outer lodicules; but the inner one, pressed between the grain and the inner pale (with the stem behind it), has been simply crushed out of existence, like its neighbor the inner lodicule.

Thus the final result is that the whole inner portion of the flower (except as regards stamens) has been distorted or rendered abortive by close pressure against the stem (due to the crowding of the florets in the spiky form), while the whole outer portion remains normal and fully developed. We have an outer pale representing a single normal sepal, and an inner pale representing two dwarfed and united sepals; we have two normal outer lodicules or petals, and a blank where the inner petal ought to be; we have three stamens, symmetrically arranged, among the faithless faithful only found; and we have finally two normal outer styles, with a blank in place of the absent inner style. The accompanying diagram, compared with that already given, will make this perfectly clear.

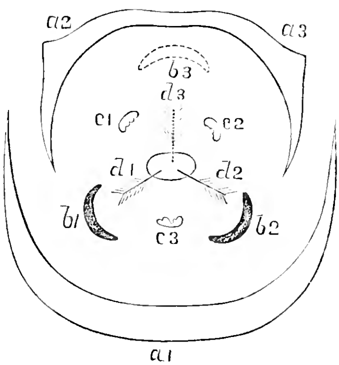

Fig. 2.

Here, a^1 represents the outer pale or normal sepal, while a^2 and a^3 represent the inner pale composed of the two united sepals. Again, b^1 and b^2 stand for the two lodicules or surviving petals, while b^3 marks the place of the lost petal, now found in the bamboos alone. The stamens are lettered c^1, c^2, and c^3. The two existing styles are shown by d^1 and d^2, while d^3 marks the abortive inner style, now not even present in a rudimentary condition. It will be observed at once that all the outer side is normal, and all the inner side more or less abortive through pressure against the axis.

Thus it will be seen that the line of links which connects the grasses and cereals with the lilies is absolutely unbroken, and that it consists throughout of one continuous course of degradation. At the same time, by this one-sided and spiky arrangement, the grasses secured for themselves an exceptional advantage in the struggle for existence. No other race of small, wind-fertilized plants could compete with them for the possession of the open, wind-swept plains; and over all these they spread far and wide, rapidly differentiating themselves into a vast number of divergent genera and species, each adaptively specialized for some peculiar habitat, soil, or climate. At the present time, the grasses number their kinds by thousands; they extend over the whole world, from the poles to the equator; and they form the general sward or carpet of greenery over by far the larger portion of the terrestrial globe. Even in Britain alone, with our poor little insular flora, a mere fragment of that belonging to the petty European Continent, we number no less than forty-two genera of grasses, distributed into more than one hundred species. In fact, what may fairly be called degradation from one point of view may fairly be called adaptation from another. The organization of the grasses is certainly lower than that of the lilies, but it fits them better for that station of life to which it has pleased Nature to assign them.

The various kinds of grasses differ very little from one another in general plan; the flower in almost all is constructed strictly on the lines above mentioned; and the leaves in almost all are just the same soft, pensile blades, making them into the proper greensward for open, unwooded, wind-swept plains. But, like almost all other very dominant families, they have split up into an immense number of kinds, distinguished from one another by minute differences in the arrangement of the florets and the spikelets; and these kinds have again subdivided into more and more minutely different genera and species. One great group, with panicles of a loose character, and very degraded spikelets, has given origin to many southern grasses, from some of which the cultivated millets are derived. Another great group, with usually more spiky inflorescence, has given origin to most of our northern grasses, from some of which the common cereals are derived. This second group has again split up into several others, of which the important one for our present purpose is that of the *Hordeineæ*, or barley-worts. From one of the numerous genera into which the primitive *Hordeineæ* have once more split up, our cultivated barleys take their rise; from another, which here demands further attention, we get our cultivated wheats.

The nearest form to true wheat now found wild in the British Isles is the creeping couch-grass, a perennial closely agreeing in all essential particulars of structure with our cultivated annual wheats. But in the South European region we find in abundance a large series of common wild annual grasses, forming the genus *Ægilops* of technical botany, and exactly resembling true wheat in every point except the size of the grain. One species of this genus, *Ægilops ovata*, a small, hard, wiry annual, is now pretty generally recognized among botanists as the parent of our cultivated corn. There was a good reason, indeed, why primitive man, when he first began to select and rudely till a few seeds for his own use, should have specially affected the grass tribe. No other family of plants has seeds richer in starches and glutens, as indeed might naturally be expected from the extreme diminution in the number of seeds to each flower. On the other hand, the flowers on each plant are peculiarly numerous; so that we get the combined advantages of many seeds, and rich seeds, so seldom to be found elsewhere, except among the pulse family. The experiments conducted by the Agricultural Society in their College Garden at Cirencester have also shown that careful selection will produce large and rich seeds from *Ægilops ovata*, considerably resembling true wheat, after only a few years' cultivation.

Primitive man, of course, did not proceed nearly so fast as that. Of the very earliest attempts at cultivation of *Ægilops*, all traces are now lost, but we can gather that its tillage must have continued in some unknown Western Asiatic region for some time before the neolithic period; for in that period we find a rude early form of wheat already considerably developed among the scanty relics of the Swiss lake-dwellings. The other cultivated plants by which it is there accompanied and the nature of the garden-weeds which had followed in its wake point back to Central or Western Asia as the land in which its tillage had first begun. From that region the Swiss lake-dwellers brought it with them to their new home among the Alpine valleys. It differed much already from the wild *Ægilops* in size and stature; but at the same time it was far from having attained the stately dimensions of our modern corn. The ears found in the lake-dwellings are shorter and narrower than our own; the spikelets stand out more horizontally, and the grains are hardly more than half the size of their modern descendants. The same thing is true in analogous ways with all the cultivated fruits or seeds of the stone age; they are invariably much smaller and poorer than their representatives in existing fields or gardens. From that time to this the process of selection and amelioration has been constant and unbroken, until in our own day the descendants of these little degraded lilies, readapted to new functions under a fresh *régime*, have come to cover almost all the cultivable plains in all civilized countries, and supply by far the largest part of man's food in Europe, Asia, America, and Australia.—*Macmillan's Magazine.*

A FEW WORDS ABOUT EATABLES.

BY C. B. RADCLIFFE, M. D.

CLERICUS. I have had a good breakfast.

Medicus. So have I.

C. I should not say so. I have emptied the toast-rack, and helped myself to three or four slices of cold roast-beef; you have had some galantine* with brown bread and butter, and not much of them. But I suppose it is all right. I am going in for a hard day's boating; you

* Something like head-cheese, but made of white meat.

are proposing to spend the day at home in finishing the diagrams, or tables, which you are going to use to-morrow at the hospital in your lecture on eatables, and which are now very much in the way when I want to see the pictures on the walls, or to take a book from a book-case. What you have taken would not enable you to do my work.

M. I am not so sure of that. At all events I am quite sure of this—that you are not wise in eating so much lean meat, in picking out every scrap of fat, and in taking no butter.

C. I want muscular power, and I feed my muscles by eating lean meat, which is muscle. I am right, so far, I suppose?

M. The muscle must no doubt be fed to enable it to act, but you are not at liberty to suppose, as you do, that the amount of urea and other excrementitious nitrogenous matter in the urine supplies the measure of the waste of muscle in muscular action which has to be repaired by food. You must seek this measure, not in the amount of urea eliminated by the kidneys, but in the amount of carbonic acid exhaled in the process of respiration; and the facts with which you have to do go to show that, after all, this food you are taking may not be that which is most suited to your wants to-day. As is shown in one of the experiments in which Pettenkofer was assisted by Voit, and as you may see in one of the tables which hide the pictures and books here—thus, No. 1—the difference between a day of rest and a day of hard work, as regards the elimination of carbonic acid and urea, is marked not by an increase in the quantity of urea, but by an increase in the quantity of carbonic acid, the actual quantities being—

	Grammes of carbonic acid.	Grammes of urea.
On a day of rest..........................	911·5	37·2
On a day of hard work..................	1,184·2	37·

On the day of hard work there is a very marked *increase* in the quantity of carbonic acid, and a trifling *decrease* in the quantity of urea. What do you say to this fact? Again: As is shown in one of the experiments of Lehmann, and as you may see in this table, No. 2, the amount of urea eliminated by the kidney is, in the main, proportionate to the amount of nitrogenous matter contained in the food; the result of feeding a dog

On a purely animal diet being.......................	53·2	grammes.
On a mixed diet "	32·5	"
On a vegetable diet "	22·5	"
On a non-nitrogenous diet, consisting of fat or grape-sugar or starch.......................................	15·4	"

Once more: As is shown by Edward Smith in an experiment upon himself, and as you may see in this table, No. 3, the amount of carbonic acid given off every minute is in direct proportion to the amount of work done in the time, the actual amount being—

During sleep	4·99	grains.
When lying down and half asleep	5·91	"
When walking at the rate of two miles an hour	18·10	"
When walking at the rate of three miles an hour	25·83	"
When turning the tread-mill at the rate of 28·65 feet in a minute	43·97	"

Similar facts are supplied in numbers by these experimentalists, and also by Fick and Wincceslaus, and Traube and Parkes, and Pavy, and other excellent observers in this country and abroad; but these three, about the correctness of which there can be no doubt, are sufficient to show that the amount of urea in the urine does not supply the measure of this waste of muscular tissue in muscular action, which has to be repaired by lean meat and other nitrogenous food, and that the food you really want to repair this waste may be carbonaceous rather than nitrogenous—simple fuel, rather than plastic material.

C. I shall, I expect, be quite ready for my dinner when I come back. I may have taken more lean meat than I wanted to keep my muscles in trim; I have not taken more than I seem to want. I have been breakfasting in this way for a long time, and I was never in better trim for a long pull than now. I may be eating too much, but you must allow that I am eating the best kind of food.

M. I do not say that you are not eating the best kind of food; I only say that lean meat is not the only kind of nitrogenous food which will serve your purpose. It is impossible to distinguish between the albuminose or peptone into which fibrine is resolved in the process of digestion and the albuminose or peptone into which albumen, or caseine, or gluten, or legumin, is resolved in this process. It is apparently of little or no moment whether these various nitrogenous articles of food are derived from the world of animal life or from the world of vegetable life. You must allow that an herbivorous animal is not less vigorous than a carnivorous animal; and certainly you would find it difficult to show that man, who can live and thrive under the most dissimilar circumstances upon almost any kind of food, is vigorous in proportion to the amount of meat he contrives to consume.

C. You can hardly wish to depreciate the nutritive value of lean meat.

M. Certainly not. All the nitrogenous substances, animal and vegetable, are resolvable into albuminose in the process of digestion, but not with the same facility in every case. Some of them are digested more easily by some persons than by others; and, besides, there may be differences in the albuminose itself which are recognizable by chemical means. In your own case, lean meat may be more digestible than any other nitrogenous compound, and the albuminose into which it is converted may be more easily assimilated. In another case, eggs or cheese or macaroni may better suit the requirements of the person taking it. I do not venture to lay down a hard and fast rule for you or any one in this matter; I only want you to understand distinctly that a person who can not get a full allowance of lean meat, or who does not choose to get it, is not necessarily ill fed for that reason, even though he have to do hard work with his muscles.

C. If a large amount of nitrogenous food is not wanted as food for muscle or other tissues—for plastic purposes, that is to say—how is the excess disposed of?

M. The part of the nitrogenous food which is not wanted for plastic purposes is, after digestion, resolved by the action of the liver into urea, and the other excrementitious products which are met with in the urine, and into a compound containing carbon, hydrogen, and oxygen, without any nitrogen, which compound *may* be the substance called amyloid substance or glycogen. This non-nitrogenous compound is destined to serve as fuel for the production of heat and other forms of force. The portion eliminated as urea, which is simply excrementitious, and the complemental portion, which is destined to serve as fuel, is as 33·20 to 66·80; and therefore it is easy to see that a large part of the nitrogenous food—but little less than two thirds, that is to say—may be devoted to other than plastic purposes, and that a little more than one third may be simply wasted. Moreover, the comparatively small portion of nitrogenous food which is actually wanted for plastic purposes is, there is reason to believe, eventually disposed of in the same way as the portion which is not used for plastic purposes, a little more than one third being wasted as urea, and a little more than two thirds being utilized as fuel. And if this be so, the question arises whether the fuel into which a large part of the nitrogenous form of food is resolved sooner or later is the best form of fuel for your purposes—whether, for example, you were wise in picking out the fat and in taking dry toast?

C. I leave you to find the answer to this question.

M. There is, I think, good reason to believe that much of the fuel without which life can not be maintained may be more easily supplied by non-nitrogenous substances than by nitrogenous substances. The fuel in nitrogenous food is not ready-made. This food has to be transformed, first of all, into albuminose or peptone, and then this albuminose or peptone has to be broken up, partly into the excermentitious portion which passes out of the system by way of the kidneys, and partly into the residual portion which is destined to act as fuel. An abundant supply of gastric and pancreatic and intestinal juices is wanted in order to bring about the proper formation of albuminose; without a healthy condition of liver and kidney it is evident that the albuminose may not be broken up (this breaking-up occurs chiefly in the liver) into urea and amyloid substance or glycogen, and that the urea (which passes out of the system by way of the kidneys) may not be eliminated. Moreover, it seems to be certain that no one can take a large amount of meat and other highly nitrogenous compounds for a long time unless he also do a large amount of muscular work—unless he do much more work of this sort than the great majority of human beings are willing or able to do. Fat and butter and oily matter generally, on the other hand, require no digestion, in the proper sense of the word. They are converted into an emulsion—which is no more than a mechanical mixture like cream, by the action of the pancreatic and duodenal juices chiefly, and by the action of the bile partly, and this emulsion passes directly into the general circulation of the blood through the lacteals directly, without going the round of the portal circulation and the liver, as albuminose has to do. Fat and butter and oily matters generally are fuel ready-made, or which only need to be emulsified in order to be in this case; and they have this advantage also—that they are burned up in the system, without leaving behind them, so to speak, any ash like urea. And, as force-producing agents—if the capacity for oxidization may be taken as a measure—the value of fat and oil is almost double that of fibrine or albumen.

C. I can see that I may have been taking too much lean meat and too little toast; I can also see that I may have been especially wrong in avoiding fat and butter; but I do not see how to set to work to reform my doings.

M. What you have to do, first of all, is to bear in mind that the daily loss which has to be made good by food, in a man of medium stature and in moderate work, amounts to 4,800 grains of carbon and 300 grains of nitrogen, and that, in round numbers, lean meat contains 11 per cent of carbon and 3 per cent of nitrogen, and bread 30 per cent of carbon and 1 per cent of nitrogen.

C. Is it so?

M. Yes. The daily rate of wasting of the system which I have mentioned is that which is brought to light by very many observations, carried on by many persons in various ways, with a view to regulate the food-rations of soldiers and sailors and prisoners, and other ration-fed people; and as to the proportion of carbon and nitrogen in lean meat and in bread the evidence is sufficiently conclusive.

C. Upon these data I can easily calculate how much meat and bread I really want if I choose to live wholly on meat or bread, and how the meat and bread ought to be apportioned if I take meat and bread together.

M. The calculation is ready made for you, and the result shows very plainly that you must mix your lean meat and bread in certain proportions if you care to feed without wasting good food. In order to replace the daily loss of 4,800 grains of carbon by lean meat, the quantity of meat you must take is 43,637 grains, or rather over 6 pounds—a quantity which contains 1,009 grains of nitrogen in excess of the 300 grains actually wanted. In order to replace the daily loss of 300 grains of nitrogen by bread, the quantity of bread you must take will be 30,000 grains, or about 4 pounds—a quantity which exceeds by 25,200 grains the 4,800 grains of carbon which are actually wanted.

C. My carnivorous tendencies, then, may not be so very extravagant, after all. I never ate 6 pounds of lean meat, or a third of that amount. I do not think I have suffered any sort of harm from the nitrogen which I may have taken in excess; I am sure I could never eat 4 pounds of bread, or half that amount, with impunity.

M. There is no occasion for you to eat these monstrous quantities of meat or bread. You must eat 6 pounds of lean meat every day if if you take nothing else but lean meat; you must eat 4 pounds of bread every day if you take nothing else but bread; but you may get on very well upon a comparatively small allowance of meat and bread if the two were combined in proper proportions. You want every day 4,800 grains of carbon and 300 grains of nitrogen; you find what you want, as Dr. Pavy shows, in 2 pounds of bread and in about ¾ pound of lean meat, thus:

	Carbon.		Nitrogen.	
14,000 grains (2 pounds) of bread contain	4,200	grains.	140	grains
6,500 " (about ¾ pound) of lean meat contain	605	"	165	"
Total	4,805	"	305	"

C. I quite shrink from the notion of having to take so much as 2 pounds of bread to make up for the daily waste of my body.

M. You need not take so much, or anything like so much, if you will take fat with your meat, or butter with your bread, or any oily matter in proper quantity. Fat is very rich in carbon, and so are all fatty and oily matters. You would have the 4,800 grains of carbon and the 300 grains of nitrogen which you want, if you took ¾ pound of lean meat and about 2½ ounces of fat. In proportion as you increase the amount of fatty or oily matter, you may diminish the amount of bread; and, within certain limits, which you may determine for yourself, you may probably please yourself as to the relative proportions of the two. Whether you would get on satisfactorily by excluding bread altogether, and taking fatty matter in its stead, is another question. The growing chick within the egg has plenty of oily matter to feed upon, and nothing of the nature of starch or sugar, or any other carbo-hydrate to take the place of bread. The sucking mammal finds a large amount of oily matter in the milk upon which it feeds, and a somewhat larger amount of lactine, or sugar of milk, which, as a carbo-hydrate, may more or less take the place of bread. In the hen's egg, the proportion of fatty matter to albuminous matter is as 82 grains to 110 grains. In cow's milk the proportion of fatty matter to lactine is as 351 grains to 468 grains, and of these two substances in conjunction, together with caseine, as 811 grains to 369 grains. In 2 pounds of bread and ¾ pound of lean meat the proportion of fatty matter to carbo-hydrates is as ·944 ounce to 16·320 ounces, and of both these substances together to nitrogenous matter as 17·264 ounces to 4·908 ounces. In point of fact, the proportions of nitrogenous matter, of fatty matter, of carbo-hydrates, and of mineral matter, in the dry constituents of a hen's egg, of a pint of cow's milk, and of 2 pounds of bread and ¾ pound of lean meat, according to Dr. Pavy, are :

1. In the dry constituents of the contents of a hen's egg :

Nitrogenous matter	110	grains.
Fatty matter	82	"
Mineral matter	11	"
Total	203	"

2. In the dry constituents of a pint of cow's milk :

Nitrogenous matter	369	grains.	·843	ounces.
Fatty matter	351	"	·802	"
Lactine	486	"	1·069	"
Mineral matter	72	"	·164	"
Total	1,260	"	2·878	"

3. In the dry constituents of 2 pounds of bread and ¾ pound of uncooked lean beef :

	Bread.		Beef.		Total.	
Nitrogenous matter	2·592	ounces.	2·316	ounces.	4·908	ounces.
Fatty matter	·512	"	·432	"	·944	"
Carbo-hydrates	16·320	"	....		16·320	"
Mineral matter	·736	"	·612	"	1·348	"

C. By thus putting the composition of egg and milk side by side with that of bread and meat, the conclusion you would have me draw, I suppose, is, not only that fatty matter is present in large quantity in the two model forms of food, egg and milk, but also that fatty matter may be made to take the place of the starch and sugar of bread.

M. By comparing the composition of 2 pounds of bread and ¾ pound of lean meat with that of eggs, you may also, I think, form some idea of the amount of fatty or saccharine matter which is necessary to replace the 2 pounds of bread. The nitrogenous matter of 6 pints of milk or thereabout is equivalent to that of 2 pounds of bread and 3 pounds of lean meat, for in 6 pints of milk there are 4·082 ounces of fatty matter and 6·416 ounces of lactine ; and, therefore, you may conclude that the 4·082 ounces of fatty matter and 6·016 ounces of lactine which are present in the 6 pints of milk are equivalent, for practical purposes, to the ·944 ounce of fatty matter and to the 16·320 ounces of starch and other carbo-hydrates which are met with in the 2 pounds of bread and ¾ pound of lean meat. The nitrogenous matter of 20 eggs is about equal to that of 2 pounds of bread and ¾ pound of lean meat, for in 20 eggs there are 1,600 grains, or 3·66 ounces of fatty matter, and therefore you may conclude that the

1,600 grains, or 3·66 ounces of fatty matter which are present in the contents of 20 eggs may take the place of its ·944 ounce of fatty matter which are met with in the 2 pounds of bread and in the $\frac{3}{4}$ pound of lean meat, and of the 16·320 ounces of starch and the other carbo-hydrates which are present in the 2 pounds of bread. For it may be fairly assumed that the properties of the nitrogenous and non-nitrogenous compounds are as properly balanced in the egg and milk, which are the two great typical forms of natural food, as they are in the artificial combination of bread and meat of which we are speaking. You may draw your own conclusions from the tables on the walls in which these facts are set forth.

C. I also find in these tables a curious correspondence as to the amount of mineral matter in the three cases under consideration. The proportion of mineral matter in the other constituents is as 1 to 18 in the egg, as 1 to 17 in milk, and as 1 to 17 in the case of meat and bread.

M. This correspondence may not be quite so close as it seems to be. In the case of the egg an uncertain amount of lime, probably a large amount, ought to be added, for the shell becomes thinner and thinner as the process of incubation goes on, in consequence of the solvent action of the phosphoric acid which is generated by the oxidization of the phosphorus in the contents of the egg. In the case of white bread (white bread was used in this experiment) the greater part of the mineral matter, which is lodged chiefly in the husks of the grain, is sifted out in the preparation of the flour from which white bread is made. The earthy matter of the shell is certainly necessary to the proper development of the bones of the chick, and in all probability the bones are not the only tissues which are in this case. A dog lives long and thrives when it is fed upon brown bread, but not when it is fed upon white bread. Scurvy also is a speedy consequence of living upon salt meat, which differs from fresh meat chiefly in the fact that the salts belonging to it have been transferred to the brine. If the body is to be properly nourished, the mineral matters which are contained in the different articles of food can not be excluded, that is evident. And if these different articles of food are to be properly digested, the common salt, in the food or taken along with the food, may have a very important work to do in addition, for without it it is not easy to see how the gastric juice could acquire that part of its acidity which depends upon the presence of hydrochloric acid.

C. I have always avoided fat and butter, on the supposition that they would make me bilious and stout. I also thought that they were specially indigestible. I knew that they were of great value as heat-producers, as "elements of respiration," as fuel, and that the inhabitants of cold countries could not get on well without an abundant supply of them, but it never entered into my head to suppose that they might take the place of meat and bread.

M. You have only to consider how olive-oil is used in the warm parts of Europe where the olive is cultivated, and how ghee is used in India, in order to satisfy yourself that oily matter may be taken with facility in hot countries as well as in cold. You hear nothing about indigestion; you find that a bad olive-harvest or scant supply of ghee is a great national calamity. A Hindoo servant of a friend who kept up his Indian habits of eating here in London has often told me that in his own case nothing would make up for a deficiency of ghee or butter, and that his experience in this matter was the common experience of his countrymen at home or away from home. He looked upon a sip of ghee in very much the same light as that in which his fellow-servants looked upon a draught of beer. "Wine is good, but oil is better," said a peasant to the courier who was with me the other day in Andalusia, and after gulping down a large mouthful of olive-oil and smacking his lips more than once, the expression of his countenance was an apt illustration of the meaning of the Scriptural text which speaks of oil as making "the face to shine." Indeed, it may be taken for granted that oil may be used in large quantities throughout the year in the hot, olive-growing countries of the south of Europe, not only without making the people bilious or out of order in any way, but with unmistakable benefit.

C. You have spoken of fat and butter and cream as force-producing agents. You mean heat-producing, I suppose?

M. No; I meant what I said. They are heat-producing agents without doubt, but heat is only one of several modes of force which are closely correlated, and there is reason to believe that the molecular movement which gives rise to heat in one case may, in another case, give rise to electricity or some other form of physical force. I do not believe that heat is transformed into muscular force or nerve-force. I believe that the oxidization of the force-fuel, which gives rise to heat in one case, may in the case of a muscle and nerve give rise to the electricity which is peculiar to muscle and nerve; that this electricity antagonizes the state of action in both muscle and nerve; that in muscle it also causes elongation of the fibers during the state of rest, and that muscular contraction is brought about by the action of the attractive force which is inherent in the physical constituents of the muscular molecules when this force is no longer antagonized by their electricity. Indeed, all that I want to bring about muscular contraction is, not a metamorphosis of muscle which issues in the development of muscular force, nor a transformation of heat into muscular force, but simply a supply of electricity during the state of muscular inaction which will counteract the tendency which the muscle always has to contract as an elastic body. I want, indeed, not a special muscular force, but merely the common attractive force which is inherent in the physical constitution of the muscular molecules, and electricity to counteract the working of their attractive force when necessary.

C. I begin to see that I should have been in equally good trim for boating upon a very different kind of breakfast—that what I wanted was fuel for force-making rather than food for muscle-making; and now that I call to mind many facts which have been brought under my notice in countries where olive-oil is a staple article of food, I can, after what you have said about the connection of electricity with muscular action, understand how a man whose food is chiefly polenta or potato, with a little bread and oil, should have had as much muscular power at his disposal as ever I could contrive to compass. I once made the ascent of Etna with two Sicilian guides, who scarcely ever tasted any animal food except a morsel of fat bacon, and who lived chiefly on polenta and bread and olive-oil. More than once I thought I should never get to the top; they trudged upward with scarcely a sign of distress, though often having to expend a good deal of strength in pushing or pulling me up. And yet I was in what I thought to be an excellent "condition" at the time.

M. Yes.

C. It is, I suppose, right to believe that most of the weaklings who are benefited in this country by cod-liver oil, in Switzerland by neat's-foot oil, and in Russia by train-oil, would never have required these oils as medicine if their food had been sufficiently rich in fatty and oily articles. Cod-liver oil, I have heard you say again and again, has no special virtue of its own; it does good simply because it is oil. In my parish, where cod-liver oil is now used, suet diffused in milk, by boiling the two together, was used formerly, and, I am told, with equal benefit. In the cases where cod-liver oil is wanted the food in all probability has been lacking in fatty or oily matter. More force-fuel was wanted, I suppose.

M. I have a notion that the beneficial action of the fats and oils is not wholly to be accounted for by regarding them merely as force-producers. I believe that they actually serve as food for nerve-tissue. This tissue is in the main made up of a peculiar kind of fat, and I am convinced that nerve is starved if the food be wanting in a sufficient quantity of fatty or oily matter. I find that very many persons suffering from various chronic disorders of the nervous system have abstained from the fatty and oily articles of food, and that their state is almost invariably very much changed for the better when you can get them to take what they have avoided; I also find that a great number of delicate infants who can not take skimmed milk, and who do not take kindly to unskimmed milk, will take milk without any difficulty when it is enriched with cream. You may say if you will, "These facts only show that the fatty and oily matters have done good in these cases by acting as force-fuel," and I do not care to contradict you flatly. Indeed, all I can say is that I do not think I am illogical in supposing that they may do good also in serving as food for nerve-tissue.

C. I gather from what you have said that you would prefer, as food for invalids, milk enriched with cream or some other fatty matter, or the yolks of eggs, or something like the *bouillon* of the French *pot-au-feu*, to highly nitrogenous preparations from which the fat has been carefully skimmed off, such as Brand's essence, or Liebig's *extractum carnis*, or ordinary beef-tea.

M. That I certainly do; lean meat more or less fluidified and its juices are not the *sine qua non* in food if what I have said be true. On the contrary, I am disposed to think that in very many cases foods of this sort are really unsuitable, if only by calling upon the liver to do work which this organ is unequal to at the time.

C. You approve, then, of the old-fashioned milk diet rather than of the meat preparations which are now so much in vogue?

M. I am quite a believer in the virtue of unskimmed milk as a most suitable food for invalids of all ages in almost all cases; and I think that, in very many cases where this fluid does not agree, this difficulty will be got over by the addition of cream or some fatty matter. I can imagine that many mothers who can not feed their infants in the proper way, or get fresh cow's milk or cream, will have reason to be glad when they can procure preparations of condensed or inspissated milk enriched with various quantities of cream or some fatty matter. I can imagine that preparations more or less similar to those, which, for the reason I have just hinted at, might properly be called brain-food or nerve-food, might make cod-liver oil almost superfluous as medicine, and be of infinite service to countless myriads of persons in whom brain-power or nerve-power is lacking. I can imagine that in many cases it will be difficult to find a food for invalids which is to be preferred to lightly boiled yolk of egg, or to ordinary egg-flip. And in the cases where it is expedient to use flesh—meat in one form or another—I am sure it will be a great change for the better when, instead of having recourse to beef-tea, or Brand's essence, or Liebig's *extractum carnis*, the thoughts are turned to something like the *bouillon* of the French *pot-au-feu*, or rather to the very thing itself.

C. In what respect is this *bouillon* better than broth or stock?

M. It is much more pleasant to the taste. It is the outcome of ages of experience in the people who have a special genius for cookery. The animal and vegetable ingredients are so blended that the flavor of no one article is predominant. The *bouillon* contains all, or almost all, the soluble portions of those ingredients which are necessary for tissue-forming or plastic purposes, and for force-production, and, when taken along with bread, it provides a meal for an invalid which is most palatable, most digestible, and most restorative. It is the basis of all good gravies and soups, becoming, for example, excellent *purée* or pea-soup when a proper portion of pea-flour is added to it.

C. What about the *bouilli* which remains behind in the pot when the *bouillon* is poured out? This can not be of much use if all, or almost all, the soluble matters have found their way into the *bouillon*. Is it much more than mere *padding?*

M. The *bouilli* can not be of any very great value as food; and I am very much disposed to think that its place may often be supplied with advantage by bread or potatoes, or some other form of farinaceous food. For myself, I should infinitely prefer a basin of *bouillon* with bread, or a basin of *purée* with bread, to a basin of *bouillon* and a plate of *bouilli* after it, without bread; and I think my instincts do not mislead me in this matter. I have a small appetite, and no superabundance of digestive power; my inclinations turn toward vegetable food rather than toward animal food, and I can easily see that farinaceous food may be really more suitable to the wants of my system than anything which is left behind in the *bouilli*.

C. I have for years been trying to make the poor in my parish acquainted with the virtues of the *bouillon* and *bouilli* of the French ordinary *pot-au-feu*,* but it never entered into my head to suppose that the *bouillon* was ever to be preferred to the *bouilli*, or that bread, or potatoes, or pea-flour, or polenta might now and then be substituted for the latter with advantage. I have also been a good deal inter-

* For making an ordinary *pot-au-feu*, Gouffé, in his "Livre de Cuisine" (Paris, Hachette, 1867), tells us to take of

Fresh meat	about	$1\frac{3}{4}$ lb.
Fresh bones (smashed)	"	$\frac{1}{4}$ "
Leeks	"	7 oz.
Carrots, Onions, Turnips	"	$5\frac{1}{2}$ "
Parsnips	"	1 "
Celery	"	$\frac{1}{8}$ "
Salt	"	1 "
Clove		1
Caramel		a very little.
Water		7 imperial pints.

Having placed the meat and bones in the stew-pan, with the bones undermost, the water is poured in, and the salt added. Then, after putting it upon the fire and allowing it to remain there until the water boils, and a scum collects upon the surface, the pan is removed from the fire and the scum skimmed off, a little cold water being first added for some purpose or other which is more intelligible to a cook than to me. Then this process of boiling, adding a little cold water, removing from the fire, and skimming, is repeated twice. Then, and not until then, the vegetables are added, and the pan is placed near enough to the fire to allow the contents to simmer (not to boil) for three or four hours. Then the *bouillon* is poured off and the *bouilli* prepared as a dish in one way or another. And lastly, when the *bouillon* is in the soup-tureen, and not until then, enough caramel is added to it to give it a delicate orange tinge—*une teinte dorée*. The lid of the stew-pan is never to be closed down tightly, for if this be done the *bouillon* is very likely to spoil by becoming thick and muddy.

The quantity given here is for four or five persons. To try and make less, Gouffé tells us, is bad economy, likely to issue in bad cookery, and this is intelligible enough, for the *bouillon* may be used in various ways, not only on the first day, but on the day following. The imperial pint, containing twenty ounces, is the pint referred to.

ested in an attempt which is being made by Messrs. Nelson, of Warwick, to introduce as cheap articles of food the inventions of our late friend Mr. J. R. Johnson, which are really properly made *bouillon*, and *purée*, and other soups in the form of dry chips. From a package of one of these preparations, which may be easily carried in a corner of the waistcoat-pocket, an excellent mess of *bouillon* or *potage* may be got in a few minutes with the help of a little water and fire, and I can easily see that the invalid and the working-man will both of them be great gainers in the matter of proper food, as well as in pocket, when this discovery is taken advantage of.

M. I, too, have been greatly interested in the articles to which you refer. I have tried the specimens which have been sent to me, and I highly approve of them. I think, indeed, that their introduction to the public marks a new epoch in the proper feeding of our countrymen, and that they will be made still more suitable for food when they are enriched to some extent by some form of fatty matter. I know how difficult it is to convince the poor of this country that all food is little more than *padding* except steaks, and chops, and cuts out of joints ; and it will be long, I fear, before they can be persuaded to avail themselves of these preparations, or to learn to make for themselves the *pot-au-feu* of our neighbors across the Channel.

C. What else have you to say in the way of criticism about my unfortunate breakfast ?

M. Only a word or two about bread and other farinaceous articles of food, and about the reason which made me prefer my gelatinous galantine of veal to your cold sirloin of beef. I think that bread may still be very properly spoken of as "the staff of life," and that other farinaceous articles of food may very properly be admitted into the same category with bread. The composition of wheaten-flour—which is more or less that of all flour prepared from cereal grain (oats, rye, barley, maize, rice, and the rest), and of leguminose seeds or pulse (peas, beans, lentils), and also of potatoes and some other tubers and roots—according to Dr. Letheby, is :

Nitrogenous matter	10·8
Fatty matter	2·0
Carbo-hydrates (starch, sugar, and the rest)	70·5
Mineral matter	1·7
Water	15·0

The nitrogenous matter consists of vegetable fibrine, albumen, and gluteine in the rough form of gluten. The fatty matter is in no way peculiar. The non-nitrogenous carbo-hydrates are starch, dextrine, sugar, gum, cellulose, and lignine—starch chiefly. The mineral articles comprise phosphates of lime and magnesia, salts of potash, and soda, and silica. Leguminose seeds or pulse contain as much as from twenty-five to thirty per cent of nitrogenous matter, mainly in a form of caseine called legumine; rice and potato contain as little as about eight per cent of nitrogenous matter, and as much as eighty per cent of starch, the amount of nitrogenous matter and starch in these articles of food being in an inverse ratio to each other. Fatty matter is especially abundant in oats and maize. It is evident, therefore, that there is much in these vegetable articles of food which may take the place of the nitrogenous and oily articles which are supplied in animal food.

There is no essential difference as to chemical composition between vegetable albumen, and fibrine, and legumine, and oily matters, and animal albumen, and fibrine, and caseine, and oily matters; there is no perceptible difference in the albuminose or peptone into which the vegetable and animal nitrogenous substances are alike transformed in the process of digestion; there is no difference in the way in which the vegetable and animal oily matters are emulsified, and then taken up directly into the general circulation of the blood. Nor is it difficult to see how the starch, and sugar, and other non-nitrogenous materials which are peculiar to vegetable bodies are disposed of within the system. The way in which starch is disposed of in the stomach and bowels is not very well made out, and all that can be affirmed with certainty is that a great part of it finds its way into the liver through the portal system of vessels, and is detained there for a time in the form of amyloid substance or glycogen—a detention which is not altogether unaccountable, for, as Dr. Pavy points out, this substance "possesses diametrically opposite physical properties to sugar, being a colloid, and therefore non-diffusible, instead of a crystalloid and diffusible." There is no sufficient reason to suppose that the action of digestion, be that what it may, is always to transform the starch into sugar; for sugar in quantity could not be formed in the stomach and bowels without passing directly into the general circulation, and so out from the blood into the urine by way of the kidneys—without making, that is to say, the phenomena of diabetes a natural state of things instead of an unnatural. Nor is there sufficient reason for supposing that the amyloid substance of the liver is transformed into sugar, for this substance is as readily oxidizable and as fit for force-fuel as sugar. Nay, it may be questioned whether sugar itself is the force-fuel which the system is in need of. There is a very rapid generation of lactic acid in the stomach and bowels when sugar is taken as food, and it is not unintelligible that it should be so; for, with the help of a ferment of some sort, grape-sugar is readily converted into lactic acid. Indeed, all that has to be done is for one atom of anhydrous grape-sugar to split up into two atoms of lactic acid. Nor is it unintelligible that a certain part of the starch taken as food should pass, as it would seem to do, not into amyloid substance or glycogen, or into sugar, but first into dextrine, then into sugar, and then into lactic acid: for, as is seen in the list which I show you, there is a close chemical correspondence between these various substances and those which are akin to them. Thus:

	Carbon.	Hydrogen.	Oxygen.
Starch } Dextrine } Cellulose } Lignine or woody matters } Gum	12	10	10
Cane sugar	12	11	11
Grape-sugar } Amyloid substance	12	12	12
Lactic acid	6	6	6

There is no difficulty, therefore, in understanding, to some extent, how it is that, under the action of pepsin, or diastase, or some other ferment, starch, and dextrine, and cellulose, and lignine, and gum, and cane-sugar, and grape-sugar, and amyloid substance, may be transformed into the lactic acid which forms so important an ingredient in gastric juice, and that the lactic acid so formed, after having done its work in digesting nitrogenous substances, may be absorbed into the circulation directly, and be there disposed of in oxidization as a very readily inflammable fuel—perhaps as the more readily inflammable of all the force-fuels. And certainly there is no reason to believe that amyloid substance or sugar is more inflammable than lactic acid, but rather the contrary, for lactic acid can not be traced, as amyloid substance and sugar can be, beyond the limits of the alimentary canal. In any case I am, I think, at liberty to assume that a good deal of starch and sugar, and of the articles akin to them, are of great use in supplying lactic acid, and that this lactic acid has to do very important work, not only in the primary processes of digestion, but also as force-fuel.

C. If this be so, the effect of taking sour buttermilk, sour milk, and sour whey—the sourness of which depends upon the presence of lactic acid—ought to be unequivocally beneficial in many cases.

M. So it is. I have long been in the habit of recommending these articles in cases where the digestive power is feeble and the circulation wanting in vigor, and I am quite satisfied that the practice is very satisfactory in its results. Instead of being "a weight to the stomach," as fresh milk often is said to be in these cases, these drinks are generally found to facilitate digestion and to keep up the warmth of the system. Indeed, by using sour buttermilk and sour whey, I have often found it possible to leave off doses like rum-and-milk, and to do without alcoholic drinks altogether.

C. I am prepared to believe what you say by what I know of the experience of those who take sour milk or sour buttermilk habitually, or who have tried the whey-cure. I have more than once heard an Irish peasant say that he misses the sour milk he takes along with his potatoes almost as much as the potatoes themselves, and that "it warms him like whisky and keeps off the rheumatiz." I have again and again felt myself benefited by taking buttermilk—by returning to what was a common practice in the district in which I spent my boyhood. And, certainly, I find it difficult to turn a deaf ear to all that I have heard in praise of the whey-cure in Switzerland and elsewhere by those who have tried it for dyspepsia and rheumatism.

M. I was led to recommend sour buttermilk or sour whey by reflecting on the very facts to which you refer.

C. What about the fattening effects of starch and sugar and other carbo-hydrates? Are these substances convertible into fat?

M. Possibly—nay, probably. At the same time I am disposed to think that in many cases the apparent transformation into fat is to be accounted for by the storing up in the system of the fatty and oily materials of the food—that these materials may remain behind by being, perhaps, less combustible than the lactic acid into which amylaceous and saccharine substances are naturally transformed.

C. You have still a word to say in justification of your preference for your gelatinous galantine.

M. The nitrogenous alimentary substances are divided into proteine compounds and non-proteine compounds. The former (the albuminous group) albumen, fibrine, caseine and their varieties, yield proteine when treated by heat and an alkali; the latter (the gelatinous group) containing gelatine and chondrine—gelatine prepared from bone and structures containing fibrous tissue, chondrine prepared from cartilage—does not yield proteine when so treated. Proteine is looked upon as the base or radical of the albuminous group; but it may only be an occasional chemical product. In any case it does not do to suppose that the non-proteine compounds forming the gelatinous group are useless as articles of food. The proteine and the non-proteine compounds are all reduced to albuminose in the process of digestion, and resolved afterward in the same way into urea and the residual force-producing compounds which in all probability is amyloid substance or glycogen. An animal soon dies if it be fed solely on gelatine; and so it does also if it be fed solely on albumen, or fibrine, or starch, or sugar, or oily matter. The different elements of food, animal or vegetable, must be mixed in certain proportions, which are not yet very clearly made out, before an omnivorous animal can thrive upon them. There may be no occasion to take gelatine as food, for gelatine and chondrine are certainly formed in the system from any kind of albuminose; there can not well be any harm in taking it, for, as I have said, it is transformed into albuminose like any other form of nitrogenous substance; and there may be great good in taking it, for the coatings of the cells and fibers of muscle and nerve are made up of a structure like elastic tissue, which yields gelatine in abundance. Indeed, the popular notion that there is something specially strengthening in jelly may not be altogether a fallacy. I can easily believe that the gelatine may be wanted to provide for the proper nourishment of the coatings of the fibers and cells of nerve and muscle, and that a lack in this provision may bring about an abnormal disposition to involuntary action in nerve and muscle. I believe that these coatings are charged as the walls of a Leyden jar are charged during the state of rest, and that the degree of this charge and the indisposition to discharge is in proportion to the integrity of these coatings; in other words, I believe that the discharge which attends upon and produces this state of action, voluntary and involuntary, in nerve and muscle alike, is more likely to happen in the case where these coatings are insufficiently developed than in the case where they are sufficiently developed; and, so believing, you will easily understand why I think that gelatine may really be of high value as an article of food.—*The Practitioner.*

SKETCH OF SIR C. WYVILLE THOMSON.

THE name of Sir Charles Wyville Thomson is inseparably associated with the first explorations of the depths of the ocean, and with having proved that abundant forms of animal life lived there where it had been believed that only a few scattering organisms were able to maintain an isolated and precarious existence. Professor Thomson was born at Bonsyde, Linlithgowshire, Scotland, March 5, 1830, and died on the 10th of March, 1882. His father was a surgeon in the service of the East India Company, and spent most of his life abroad. His grandfather was a distinguished clergyman of Edinburgh; and his great-grandfather was "Principal Clerke of Chancellary" in the time of the Rebellion of 1745. He went to school at Merchiston Castle Academy, which was then conducted by Mr. Charles Chalmers, a brother of the eminent Rev. Dr. Chalmers, after which he entered the medical course of the University of Edinburgh, in 1845. After three years of study here, he began to feel the effects of overwork, and, as a means of gaining a year's rest, we are told, he took the lectureship on botany in Queen's College, Aberdeen. In the following year he was appointed to lecture on the same subject in Marischal College and University. In 1853 he was chosen to the professorship of Natural History in the Queen's College, Cork, and a year after that to the chair of Mineralogy and Geology in the Queen's College, Belfast. He distinguished himself from the very beginning of his active career as an investigator among the lower forms of animal life. His first published paper appears to have been one on the application of photography to the compound microscope, which was read before the British Association in 1850. While at Aberdeen he published several papers on the Polyzoa and Sertularian Zoöphytes of Scotland,

and some speculations on the development of certain medusoid forms, which attracted notice and were considered too daring by Johnston and Edward Forbes. During this period, too, he entered upon those researches of the crinoids of past times and the crinoidal forms of modern times, of which he took *Comatula rosacea* as a typical specimen, which, with their direct and indirect results, led him up to the grand work of his life. A British pentacrinus had been discovered and described by Vaughn Thompson thirty years before, and determined by him to be but the young stage of the "rosy feather-star," but nothing more had been learned about it. Professor Thomson undertook to complete the investigation and fill out the life-history of the animal; and the account of his researches was given to the Royal Society in 1862 and published in the volume of the "Philosophical Transactions" for 1865. This investigation on the pentacrinoid stages of comatula was but a part of a series of observations on the genus *Pentacrinus* itself, and Professor Thomson collected a mass of material with the object of writing a memoir on the group.

Up to nearly this time, it had not been believed by scientific men that life did or could exist below a certain depth of the sea. Professor Forbes had admitted the existence of a zone of deep-sea coral extending from fifty fathoms below the surface to an unknown depth, a region in which, he held, "as we descend deeper and deeper, its inhabitants become more and more modified and fewer and fewer, indicating our approach toward an abyss where life is either extinguished or exhibits but a few sparks to mark its lingering presence." This skepticism, however, was becoming weaker under the testimony of living specimens that were from time to time brought up from undoubtedly great depths.

About 1864, Mr. G. O. Sars, of the Norway Fisheries Commission, dredged up a number of specimens of a strange crinoid from a depth of seven hundred feet, and, continuing to dredge, found an abundance of animal life at about the same depth. Professor Thomson was invited by Sars's father, the illustrious Professor Michael Sars, to visit Christiania and see the specimens. The two, after examining them, concluded that they were closely related to one of the fossil genera, allied to the family of the *Apiocrinidæ*. Here, then, they had a living representative of a group supposed to be extinct, and of a form which had lived over from the Cretaceous epoch.

In 1868 Dr. Carpenter, being engaged in investigations on a living crinoid from the West Indies, visited Professor Thomson to discuss the subject in which they were both interested; and on this occasion Thomson told his visitor that the one unexplored field awaiting the investigation of naturalists was the sea; that he was convinced that when explored it would yield immense treasures to science; and suggested to him to use his influence with the Admiralty to secure the grant of a vessel, suitably fitted up for deep-sea research. The use of the surveying-ship Lightning was granted, and with it a cruise was made in the North Atlantic Ocean in August and September, 1878. Among the results of the expedition was the procuring of evidence that animal life was varied and abundant at depths of between six and seven hundred fathoms; that great masses of water at different temperatures were moving about, each in its particular course; and that many of the deep-sea forms of life were closely related to fossils of the Tertiary and Cretaceous periods.

In 1869 the surveying-ship Porcupine was lent for exploration, and made a survey of the west coast of Ireland, under the scientific direction of Mr. Gwyn Jeffries, and of the Bay of Biscay and the track of the Lightning's survey under Professor Thomson. The Porcupine was lent again in 1870, but Professor Thomson was prevented by ill-health from engaging in the surveys, and they were conducted to Gibraltar by Mr. Gwyn Jeffries, and in the Mediterranean by Dr. Carpenter. By the time the Porcupine's survey was completed, and under the promptings of the results obtained in the previous surveys, an extensive scientific interest in work of this kind was awakened. A representation was made to the Government by the council of the Royal Society, urging that an expedition be dispatched to investigate the great oceans and take an outline survey of their bottoms. The proposition received general support, and was acceded to by the Government, who granted the Challenger, a main-deck corvette of 2,306 tons, for the use of the expedition.

Captain G. S. Nares, R. N., was called from the survey of the Gulf of Suez to take charge of the vessel, and the second place in command was given to Commander J. P. Maclear, R. N., son of the late Astronomer Royal at the Cape of Good Hope. Professor Thomson was given the scientific direction of the expedition, and took as his associates Mr. J. J. Wild, of Zurich, private secretary; Mr. J. Y. Buchanan, of Edinburgh, chemist; and Mr. H. A. Moseley, Dr. von Willemoes Suhm, and Mr. John Murray, naturalists. The vessel was fitted up with all the appliances which the forethought of the naval experts and scientific men interested in the preparation for the expedition could devise for making the delicate and often complicated observations which were to be undertaken, some of which had hardly been attempted before on other than an experimental scale. The plans were prepared by the Admiralty in conjunction with a committee of the Royal Society, and reasonable liberty of variation from them, when circumstances might make it expedient, was allowed to the two chiefs. The personal composition of the expedition was changed during the voyage by the recall of Captain Nares, to take charge of an Arctic expedition, and by the death of Dr. Willemoes Suhm. Otherwise the plan was carried out essentially as arranged in the beginning. The special object of the expedition was to investigate the physical and biological condition of the great ocean-basins.

The Challenger left Sheerness December 17, 1872, and crossed the Atlantic four times, making a course of nearly twenty thousand miles during 1873; in 1874 she went southward from the Cape of Good Hope, spent nearly a month among the southern ice, dipping into the Antarctic Circle as far as she could with safety, then traversed the seas of Australia and New Zealand, made observations in the Malay Archipelago, and reached Hong-Kong in November, after making a course of more than seventeen thousand miles; in 1875 she traversed the Pacific, making a course of about twenty thousand miles, and in the early part of 1876 she crossed the Atlantic for the fifth time, to fill up blanks in her former observations, finally reaching England in May.

During this course of 68,890 miles, 362 stations were established, and observations and collections made at them. The magnitude of the collections is illustrated in a statement made by Professor Alexander Agassiz, that, "if a single individual, having the knowledge of eighteen or twenty of the specialists into whose hands they were to be placed, were to work them up, he would most certainly require from seventy to seventy-five years of hard work to bring out the results which the careful study of the different departments ought to yield." They were assigned to various gentlemen recognized as authorities in different departments for description group by group.

The most prominent and remarkable result of the voyage was the final establishment of the fact that the distribution of living beings has no depth-limit, but that animals of all the marine invertebrate classes, and probably others also, exist over the whole of the flora of the ocean. But, although life is thus universally extended, probably the number of species, as of individuals, diminishes after a certain depth is reached.

Professor Thomson had been led by his researches in the Lightning to the belief that the chief formation now going on in the bed of the Atlantic was a chalk, "*the* chalk of the Cretaceous period." This belief grew more firm with continued investigations, but was modified after the Challenger Expedition, when the species deposited were found to be in very few instances identical with those of the chalk, or even with those of the modern tertiaries. "But," he added, in his address on the subject before the British Association, in 1876, "although the species, as we usually regard species, are not identical, the general character of the assemblage of animals is much more nearly allied to the cretaceous than to any recent fauna."

Professor Thomson had been elected in 1870, previous to the dispatch of the Challenger Expedition, Professor of Natural History in the University of Edinburgh, succeeding Dr. Allman. He was only relieved from duties during the expedition, and held the professorship until October, 1881, when he resigned it upon a retiring allowance granted him by the Senatus. Immediately on Professor Thomson's return, testimonials of appreciation of his services to science began to come in from various quarters. He had already been a Fellow of the Royal Society since 1869. He was now knighted in June, 1876; then he was awarded one of the gold medals of the Royal Society; was toasted by Professor Huxley at a scientific banquet given at Edinburgh in honor of the expedition; was created by the King of Sweden a knight of the Order of the Polar Star at Upsala, where he went with Professor Balfour, as a representative of the Edinburgh Senatus, to attend the tercentenary of the ancient university; was made LL. D. at Aberdeen, D. C. L. at Dublin, a Doctor of Philosophy at Jena, D. Sc. and Fellow of various British and foreign societies. In 1877 he was appointed to deliver the Rede Lecture at Cambridge. In 1878 he presided over the Geographical Section of the British Association, and took as the subject of his address, "The Advances which have been made in Late Years in the Application of the Physical Sciences to the Illustration of the General Condition of the Earth." He was also Vice-President of the Jury on Raw Products at the Paris Exhibition of 1867. He took the lead in organizing the School of Art in Belfast, under the Science and Art Department, and was the chairman of the first board of directors. He was a Conservative in politics, and was a magistrate and Commissioner of Supply for the county of Linlithgow.

His health, never very vigorous, was not improved during his voyage on the Challenger. In June of 1879 he was attacked with paralysis, and had to suspend the conduct of his classes in the university, and lay aside the work of superintending the compilation of the Challenger's researches. He was never able to work steadily afterward. He had a second attack about four months before his death, after which he seemed to be getting along through the winter tolerably well, till about two weeks before his death, when he got a severe chill from exposure, from which he never recovered.

Sir Wyville Thomson's principal literary works include "The Depths of the Sea," containing the accounts of the expeditions of the Lightning and the Porcupine, in which is given all that is known as to the records of the existence of deep-sea life up to 1865; the "Voyage of the Challenger. The Atlantic," in two volumes, giving a preliminary account of the general results of the Challenger Expedition; and his part of the work in the formal official report of the expedition, of which he lived to see only the first three volumes completed. At the time he was prostrated, he was preparing for the press a narrative of the voyage, to appear in the official work, based on one drawn up by Staff-Commander Tizard, the chief commanding officer of the Challenger. He also delivered several public addresses before scientific and popular bodies, which were marked by clearness of statement and sustained interest. The departments of zoölogy to which he devoted most attention were those which included the corals, crinoids, and sponges, and upon these his opinion was regarded as of great weight. He was, says "Nature," speaking of his residence at Belfast, "something besides an enthusiastic biologist. . . . By interesting himself not only in what concerned the college, but even in the welfare of the town in which it was located, he soon gathered around him a host of intelligent and warm-hearted friends. In social life, it was but an accident that would reveal the biologist, and one witnessed only the general culture and the artistic taste of a well-bred man."

His associate in the Challenger Expedition, Mr. Moseley, has given, in a notice in the "Academy," a graphic sketch of his personality as it manifested itself during the observations on board the vessel. "His enthusiasm," says Mr. Moseley, "with regard to everything connected with the dredging, sounding, and various physical and chemical operations carried on in the deep sea during the cruise, knew no bounds. He spent hours on deck watching them, and waiting for the dredge to come up, and though, as time wore on, the interest of the seamen and naval officers in the arrival of the dredge or trawl at the surface failed, and that even of the remainder of the scientific staff flagged, he was never known to be absent at the moment it appeared at the ship's side, whatever the weather, but was to be seen peering down into the water, eagerly attempting to diagnose the contents of the net when it was still dipping in and out of the sea-surface as the ship rolled to and fro. When once it was on board, he would eagerly grope for treasures, squeezing each cephalopod between his fingers, always with a lurking hope to find a belemnite's bone in it, or expecting at last to grasp a trilobite. These never came, but there was an abundance of other wonders."

Concluding his sketch, Mr. Moseley says: "Sir Wyville was an excellent lecturer, a most genial companion, and an excellent host. He was fond of amusements of all kinds, and was never happier than when he went on shore from the Challenger in some out-of-the-way island, with his gun on his shoulder, in pursuit of birds-of-paradise, or other treasures."

A fund of five hundred guineas has been raised by subscription for erecting a memorial to Sir Wyville Thomson; with respect to which it has been decided that a bust by Mr. J. T. Hutchinson, R. S. A., shall be placed in the University Hall, Edinburgh, and that what is left of the fund shall be devoted to putting a stained-glass window in the church of St. Michael at Linlithgow.

EDITOR'S TABLE.

LAW AGAINST RIGHT.

WHATEVER truth there may be in the declaration that "paper constitutions will not work as they are intended to work," it is very certain that written and unwritten constitutions do not work in the same way, and do affect the habits of mind of the people very differently. In England "the Constitution" is a body of precedents and practices, which are interpreted and applied to new cases in accordance with the historic spirit of the Government; while in this country "the Constitution" is a printed document that may be bought for a nickel, and learned by heart in a week. To find out the meaning and obligations of the English Constitution, we are referred to the principles of the national policy; to find out the requirements of our own Constitution, we are referred to its explicit clauses. These Constitutions do not work alike; and in one important respect they do not work as we should anticipate. We should naturally expect that the English Constitution would be so complex a thing as to be far removed from the people, and create a multitude of law interpreters, who would practically have the whole subject in their own hands. And at first sight it would seem that with a written constitution so much is gained in the way of simplicity, where everything is made as plain, definite, and positive as language can make it, that the people should perfectly understand the instrument, and there would be little need of professional commentators. But, in point of fact, the English Constitution is by no means withdrawn from the consideration of the English people, nor does the simplicity of our own written charter save us from the need of a host of lawyers. Yet there is a divergence in the function of the lawyers in the two cases, which corresponds to an equal diversity in the mental habits of the people in the respective countries. Where the supreme law is unwritten, and has to be sought in the usages and principles of the government, the process of its interpretation is far more open than in the other case, more a matter of adaptation and readjustment. Tendencies and progress and new circumstances are taken into account, and each step of the elucidation becomes a part of the continuous national process of establishing the Constitution. The people know the fundamental principles, the great landmarks of guidance, which are to control the course of lawyers and judges, and they can understand whether the supreme objects of the Constitution are fulfilled or defeated. Appeal will naturally be made to the more rational and liberal elements of the national policy, and the task of amending and improving the Constitution itself will be felt as a permanent responsibility. The men of to-day are, therefore, as much "founders of the Constitution" as those of former generations.

But it is very different where the Constitution is a written document which was made the supreme law in a former age. Only the glorified "fathers" are here ranked as founders of the Constitution. It embodied the ideas and the wisdom of its time; but all questions are closed by it, save those of the verbal significance of its clauses. It is amendable only through political spasms, and by an implied impeachment of the patriots who formed it, and whom there is an increasing tendency to regard as infallible. Questions of interpretation necessarily arising, tend to become narrow and technical, a matter of rules and definitions, while the lawyers will naturally become expert in all the arts and artifices of word-manipulation. Under such a system the letter of the law will tend to take the place of the spirit and purpose of the law. In these circumstances there will arise the habit, both on the part of lawyers and of citizens, of reverencing the forms of law more than the principles which lie behind them. The purposes by which all legislation should be animated and determined will come to be habitually overlooked. Questions of right and justice will be ruled out as irrelevant, the highest and only solicitude being as to the binding phraseology of specific clauses. In this way the whole apparatus of justice may be perverted to the work of stifling the national conscience, and the real purposes of government defeated by its own agencies. There are various exemplifications of this, to which it may be well to call attention.

The London "Economist," when some time ago discussing the privateering question with reference to England, Russia, and America, recognized the point here made, by stating that the United States may be expected to fulfill its treaty stipulations, but that it will do so from a lawyer's point of view as to their meaning and obligation. It says: "The Government of the United States is not a dishonest Government, or even a tricky Government, widely as that impression is diffused. Owing to circumstances upon which it is unnecessary here to enter, it is a Government very much in the hands of lawyers, and of lawyers trained to encounter one another by means of the quibbles, devices, and 'sharp' interpretations of law which a generation ago were so much in vogue among ourselves. Such men are very apt to read contracts strictly, to seek loop-holes when clauses in those contracts are inconvenient, and to suggest interpretations which give them an apparent advantage, and this practice undoubtedly annoys foreign diplomatists, who do their little trickeries in a different and, as they think, a more gentlemanly way. But the same training inspires in the American party-leaders a great respect for law itself, and especially for written law, great acuteness in interpreting it, and a great reluctance to see it neglected, and they are no more likely to break or evade unmistakable rules than English judges are."

The treatment of the slave question in England and the United States well illustrates the diverse working of their constitutions. It was by a recognition of the predominance of the spirit of the English Constitution that Chief-Justice Holt was led, early in the eighteenth century, to decide that "as soon as a negro slave comes into England he is free." This decision, after being long resisted, was reaffirmed by Lord Mansfield in 1772 in the celebrated case of Somerset. These decisions settled the principle that the English Constitution was adverse to slavery. But of that celebrated jurist and eminent legal reformer, Lord Mansfield, it has been remarked that "his eagerness to discourage technicalities and his preference of the principles of civil law occasionally led him to make the law instead of expounding it." This, however, is the American view of the American biographer who forgot the constitution-making function of the English judge. Both Holt and Mansfield, in their great decisions, simply fell back upon the principles of natural justice, which they assumed it to be the supreme object of the English Constitution to secure; and, it being established forever that "a slave can not breathe in England," the policy of hostility to slavery became national, and was carried out in the gradual and pacific emancipation of all slaves in the British dependencies. The struggle was long and the progress slow, but the result was a triumph of the principles of right over the selfishness and greed that were legally embodied in the slave system.

It was far otherwise in this country. Slavery created by law was unquestionably recognized and protected by the American Constitution. Yet there were provisions in the instrument which, if liberally and humanely interpreted, would have destroyed it. The Constitution, however, was construed literally, verbally, and technically, and no question was permitted to be raised in regard to the principles of justice which should underlie all such charters, and which were profusely declared in its preamble to pervade the American Constitution. The written Constitution thus, in fact, became the bulwark of slavery, and was accordingly denounced by the passionate reformers as "a league with death and a covenant with hell." To go behind the literal constitutional provisions for the protection of slavery was denounced as virtual treason. The question of abstract right and wrong was held to be irrelevant and impertinent; the slave system was legal, and therefore not to be meddled with. Henry Clay laid down the American formula upon the subject in the Senate of the United States in 1838, in the following words: "What the law declares to be property *is* property." This was the lawyer's view, and it was also the people's view; and it was this triumph of law over right that maintained slavery until, American civilization proving unequal to the contest, it was ended at last by the barbarism of war.

Equally marked has been the contrast of the English and American policies on the question of the rights of authors to property in their works. We have referred to this before, but our people can not be reminded of it too often. The question is one of no little perplexity, but very easily befogged, and it is well fitted to test statesmanship and national character.

It had been long felt in England that arrangements upon the subject of copyright, both national and international, were imperfect, and there was a growing demand for their amendment. The government understood its duty in the matter, and a few years ago a parliamentary commission was appointed to sift the whole subject, to report upon the deficiency of existing legislation, and what practical measures of improvement are demanded. The commission was ably constituted, and made a deliberate and exhaustive investigation, summoning before it the weightiest men both at home and abroad, and patiently taking their testimony, whatever its bearing or import. The report recognized the question as one of national importance, and as involving grave state obligations. There was no quibbling or paltering about the rights of authors. The sophistries of crotchety witnesses were brushed aside, and it was broadly affirmed as a matter of radical justice that when a man produces a book by his labor he has a right to property in it which the government is imperatively bound to protect. The subject, moreover, was lifted out of the sordid sphere of mere political expediency, which dominates so widely in international intercourse. The temptation was sore to reduce it to the trading basis of reciprocity, but this temptation was firmly resisted. It was felt that, whether America will grant copyright or not, the course of England is clear. In the report made by the commissioners in 1878, they say: "It has been suggested to us that this country would be justified in taking steps of a retaliatory character, with a view of enforcing, incidentally, that protection from the United States which we accord to them. This might be done by withdrawing from the Americans the privilege of copyright on first publication in this country. We have, however, come to the conclusion that it is advisable that our law should be based on correct principles, irrespective of the opinions or policy of other nations. We admit the propriety of protecting copyright, and it appears to us that the principle of copyright, if admitted, is one of universal application. We, therefore, recommend that this country should pursue the policy of recognizing the author's rights, irrespective of nationality."

Very different was the treatment of this question under similar circumstances by the American Government. Its attitude in regard to the rights of authorship has long been the scandal of the civilized world, and efforts from time to time have been made to induce a change in the national policy. A committee of the United States Senate was appointed in 1873 to consider the subject, and report what action it is desirable to take. The proceeding that followed was nothing less than disgraceful, evincing, as it did, a contemptuous indifference toward the whole subject. Not the slightest interest was expressed in it, either as a question of private right or public honor. While the English report opened the whole inquiry on broad moral grounds, the American report sharply closed it to all considerations of equity, justice, and right. While the hand of the lawyer was hardly discernible in the English document, no other hand was visible in ours. Instead of a valuable and instructive statement befitting the magnitude and seriousness of the question, the American report was but a shabby tract of half a dozen pages, arguing as usual that the Constitution is in the way of any change of existing practices. In the discussion before the committee, arguments on the right and wrong of the question were objected to by the senatorial chairman as irrelevant, and under his ruling the debate shrank into a mere pettifogging wrangle over constitutional clauses, and a ventilation of the most ridiculous projects, which were held in the report to show that the American people are not agreed upon the subject. The committee declared that they saw nothing wrong which it is desirable to correct, and recommend Congress to take no action in the matter. It was but another exemplification of the way legal and constitutional forms are used in this country for the protection of palpable wrongs. Instead of asking first what is right, and then demanding that the law shall be made to conform to it, the people, like the lawyers, ask first what is the law, and then hold that this determines the right.

"*PIRATICAL PUBLISHERS*," *OR A PIRATICAL GOVERNMENT.*

We print a brief discussion of the copyright question, by Mr. Leonard Scott, under the title of "Piratical Publishers," which, whatever its demerits, has at least the merit of being thoroughly American. Although discussing the question how a given act should be morally characterized, his standard of judgment is but the dictum of American law.

It is not easy to defend a right and its opposite wrong by the same argument, as the reasons which favor the one destroy the other. Hence, in most discussions upon the subject, it will be found that those who oppose international copyright do it upon grounds that are equally subversive of domestic copyright. All arguments which put the public advantages of cheap literature above the rights of authors to property in their books, tell just as effectually against the American as the English author, and logically require the immediate destruction of American copyright laws. If the taking of Professor Tyndall's book from him without payment, that the American public may have it cheaply, is no crime, neither would the taking of Professor Silliman's book, for the same purpose, be a crime. Mr. Scott reasons that, although a right might be conceded in a Utopian state of society, where one universal government should legislate for the equal advantage of all, yet, as this is not the case, and dishonesty is the common policy, the right of the individual may be properly denied. But what is the limit to this principle? How does existing dishonesty make an excuse for still further dishonesty? If, because the nations are governed by selfishness, we may take an Englishman's literary property without paying him for it, is there not sufficient rascality, jobbery, fraud, corruption, plunder, and general selfishness in the operation of the American Government to justify the consistent fleecing of an American author also? Again, Mr. Scott maintains that because we send experts abroad to collect information about manufacturing processes, institutions, etc., and do not pay for it, therefore he sees no "*moral wrong*" in taking larger amounts of information in the shape of books without paying for them. But do not Western capitalists send on their experts to the East to pick up information for Western use in the construction and operation of manufacturing establishments for which appropriated knowledge they never think of paying? Would there, therefore, be no moral wrong in taking an American author's book on manufactures without compensation? If the logic is good for anything, it cuts up all copyright, root and branch.

Mr. Scott furthermore says, "The whole system of laying duties upon foreign merchandise is one of pure selfishness, and as much a robbery or piracy of the natural rights of the foreigner as anything yet done by an American republisher." But because we shackle our trade, and thus injure the foreign manufacturer, certainly affords no good reason for robbing a foreign author of his property.

But Mr. Scott is most eminently American in the following statement: "The withholding of an international copyright law does not take away from them [foreign authors] what they never possessed or had any right to claim. The American republisher, therefore, in the absence of such a law, buys the English book at the English price, and thinks that he has done all that is required of him to become its absolute owner, to do with it whatever the laws of his country do not forbid. Who shall say that among these rights is not the right to reprint it?"

Must we not conclude that this paragraph betrays some perversion of the moral sense? The author who creates the book by his labor, and makes it valuable property, is denied even the poor "right to claim" the ownership of that property; while the publisher, who simply buys a single copy, becomes its "absolute owner," with "the right to reprint it" and to go on multiplying it as long as he can make money out of its market value. This is pretty rank doctrine, and we do not see how those who hold it need have much squeamishness about the terms in which it is characterized. Yet Mr. Scott's article is a protest against the calling of American republishers pirates, as he alleges is done by their foreign "calumniators."

Now, there are two questions here: (1.) Is the term "piracy" properly applicable to any form of republication in this country? And (2), if so, who is chargeable with it? The taking by one person of another person's property without consent or payment is held as a crime, is called stealing, and he who takes it is known as a thief. If such appropriation is accompanied by violence, it is commonly called robbery. If the property has that peculiar form which is termed literary, and is appropriated by indirection, as where the embodiment of it is indefinitely copied, the taking of it, without permission and without remuneration, has in it the peculiar meanness which has led to its being metaphorically branded as "piracy." It is the flagrant wrong of the transaction that is marked by the term of reprobation, and those are pirates who are guilty of perpetrating it.

Where American republishers negotiate with the foreign owners of books, and pay them for the liberty of reprinting, there is of course no piracy, and there has been an increasing tendency in recent years on the part of American republishers to recognize the foreign author's ownership of his book, and to pay him for it. But, while this practice has been growing on the part of reputable publishers, so as to have become a rule with many of them, another class has come into the field who scout all notions of authors' rights, and reprint everything they can get hold of and make a profit on. These are not shop-lifters, or burglars, or highway-robbers, or horse-thieves, but they are book-thieves: they steal literary property by pirating the works which they have not paid for and which do not belong to them.

But an objection will be raised here—an American objection—and, if an American dictionary is consulted, it will be found that piracy is defined as an "infringement of the law of copyright by publishing the writings of other men without permission." Therefore, it will be said, American republishers break no law, and are, therefore, not pirates. The escape is but technical; the moral quality of the transaction remains, and only where the moral sense has been bedeviled, so that men are insensible to the intrinsic nature of the act, will any such pretext be urged. The foreign author has a copyright by law, and we recognize that copyright by law is in itself a righteous thing. If he can not extend the law as far as his books are demanded, it is no fault of his; he has done everything in his power to protect his own rights. His books are stolen by our publishers, and they quibble that they are not pirates because there is no American law against such literary theft. But this changes nothing in the essential nature of the transaction; it only shifts the responsibility. If our thieving publishers are not piratical, it is because the Government gives them a technical relief from the charge by itself assuming the odium. If the publishers sneak behind their Government to shelter themselves from an opprobrium, then the opprobrium must be fastened upon the Government. The wrong is committed in its most deliberate and aggravated form, and if we have not "Piratical Publishers" then we have a piratical Government. There is no blinking the scandalous fact; and the responsibility of it must rest somewhere. When a whole class of men are engaged in open, systematic, and extensive stealing—appropriation to themselves, without payment or consent, of property not their own—if the state abets them in the practice by refusing to forbid it, the state is entitled to all the execration demanded by the crime. The attitude of the American Government on this question is a reflection upon the national character in the eyes of the civilized world. We may meet this with brazen-faced assurance, and twaddle about the dissemination of cheap information among the people, but we can not divorce cause from effect in the political any more than in the physical world, and the consequences of perpetuating a great national injustice will tell with infallible certainty in the degeneration and degradation of the national character.

LITERARY NOTICES.

Facts and Phases of Animal Life, interspersed with Amusing and Original Anecdotes. By Vernon S. Morwood, Lecturer to the Royal Society for the Prevention of Cruelty to Animals. New York: D. Appleton & Co. Pp. 286. With Engravings. Price, $1.50.

The author has endeavored to describe, especially for the young, in simple language, the marvelous organization, the instinct, memory, sagacity, and inventive faculties of some of the more common animals and insects. He has also made a prominent presentation of the fidelity, love, affection, and other pleasing characteristics which all animals exhibit, more or less, one to another, in order to cultivate in his readers a higher regard for all animals, and to lessen the aversion with which some animals are contemplated. The whole is varied and illustrated with numerous anecdotes. The usefulness of animals and the services they render to man are discussed in a more general manner, and the considerations which should induce a kindly treatment of them are presented in the final chapters. The subject-matter of the work, its arrangement, even to the chapter-titles, the method of treatment, the anecdotes, the style, and the author's genial manner, are all adapted to excite and hold interest, and make the book an excellent one to put into the hands of children.

Swift. By Leslie Stephen. Harper & Brothers. 1882.

This is an interesting example of the influence of modern knowledge upon our estimate of character. Swift's life, as presented by his earlier biographers, has left the impression that he was so unlike the rest of the world that he could not be judged by ordinary rules; that the traits of his character were inharmonious and inexplicable. He has been set down as a sort of human monster, as made up of the rarest genius, the most unusual kindness, and the most abominable cruelty. But, when we rise from the perusal of this little volume, we find that our abhorrence has been changed to tender sympathy for the misfortunes of this extraordinary man.

Mr. Stephen does not think that Swift was a blameless man. In considering his conduct toward the women he loved, when he can no further unravel the threads of the story and consistently explain events, he closes with this sensible and kindly remark: "It is one of the cases in which, if the actors be our contemporaries, we hold that outsiders are incompetent to form a judgment, as none but the principals can really know the facts."

As an example of Stephen's mode of treatment, take the following. After giving na account of the poverty endured by Swift in his youth, the author remarks: "The misery of dependence was burned into his soul. To secure independence became his most cherished wish; and the first condition of independence was a rigid practice of economy. We shall see hereafter how deeply this principle became rooted in his mind; here I need only notice that it is the lesson which poverty teaches to none but men of strong character." This trait is again referred to in connection with Swift's behavior to Stella and Vanessa. He says: "Swift had very obvious motives for not marrying. In the first place, he became almost a monomaniac upon the question of money. His hatred of wasting a penny unnecessarily, began at Trinity College and is prominent in all his letters and journals. It colored even his politics, for a conviction that the nation was hopelessly ruined is one of his strongest prejudices. He kept accounts down to half-pence and rejoices at every saving of a shilling.

"The passion was not the vulgar desire for wealth of the ordinary miser. It sprang from the conviction stored up in all his aspirations that money meant independence. Like all Swift's prejudices, this became a fixed idea which was always gathering strength. He did not love money for its own sake. He was even magnificent in his generosity. He scorned to receive money for his writings; he abandoned the profit to his printers in compensation for the risks they ran, or gave it to his friends. His charity was splendid, relatively to his means. In later years he lived on a third of his income, gave away a third, and saved the remaining third for his posthumous charity, and posthumous charity, which involves present saving, is charity of the most unquestionable kind. His principle was that, by reducing his expenditure to the lowest possible point, he secured his independence, and could then make a generous use of the remainder. Until he received his deanery, however, he could only make both ends meet. Marriage would, therefore, have meant poverty, probably dependence, and the complete sacrifice of his ambition. If, under these circumstances, Swift had become engaged to Stella, he would have been doing what was regularly done by fellows of colleges under the old system. There is, however, no trace of such an engagement. It would be in keeping with Swift's character if we should suppose he shrank from the bondage of an engagement."

Egotism and love of dominion were also dominant traits of his character, which, along with his love of independence, his almost diseased sensitiveness, and his life-long ill health, enable his biographer to give, in most cases, a consistent view of his life. But, when psychology breaks down, medical science steps in and completes the rational account of this hitherto mysterious man.

Readers of the "Monthly" will remember an article by Dr. Bucknill, in the April number of last year, giving an account of "Dean Swift's disease." We were there told of Ménière's recent discovery of a definite form of disease—labyrinthine vertigo, which is shown by conclusive evidence to have been the "cruel illness" to which Swift so often alludes in his journal and correspondence. From the age of twenty he suffered from this disease, whose characteristic symptoms are, that the patient is suddenly seized with vertigo and a feeling of nausea or positive sickness, with great constitutional depression and faintness.

"This fact," says Stephen, "requires to be remembered in every estimate of Swift's character. His life was passed under a Damocles's sword. . . . The references to his sufferings are frequent in all his writings. It tormented him for days, weeks, and months." Dr. Bucknill says that it was not necessarily connected with the brain-disease which ultimately came upon him, but it accounts for the terrible anxiety always in the background, and for much in Swift's gloomy despondency.

We commend the book, as well for its intrinsic charm, as because it dispels a most painful feeling in regard to one of the greatest of men.

Herbert Spencer on American Nervousness: A Scientific Coincidence. By George M. Beard, A. M., M. D. New York: G. P. Putnam's Sons. Pp. 17. Price, 50 cents.

The late Dr. Beard, as is well known, has for some years made a professional study of nervous diseases, and has published a book, which was duly noticed in these pages, entitled "American Nervousness." As was natural, writing and publishing much upon the subject, he came to regard himself as a representative man who had made the field very much his own; and, as was equally natural, he grew somewhat sensitive in regard to the recognition of his claims.

The present pamphlet has its origin in this state of feeling. It is put forth as a reclamation of ideas which he regards as belonging to himself, and which have been used, he thinks, without due recognition of this fact. He is of the opinion that Mr. Herbert Spencer was to a very notable extent indebted to him, consciously or unconsciously, for the distinctive ideas of his speech at the late complimentary dinner in New York. Dr. Beard does not accuse Spencer of plagiarism; indeed, he repeatedly disclaims the accusation. Yet he declares that there is a "coincidence," both of thought and language, between what he had published and Mr. Spencer's expressions, that is so remarkable as to justify calling public attention to it by printing the respective statements in parallel columns. There is here, if not an insinuation of plagiarism, at least an oblique imputation of literary indebtedness not acknowledged.

Dr. Beard is at the pains to say that his action in this matter is not entirely of his own motion; he has been influenced in it by others. He remarks: "I have not been the first or only person to notice this parallelism; it has been the subject of independent comment by various individuals. The frequency of these comments led me to make the following detailed comparison." Dr. Beard was here mislad, both by his own bias and the bad judgment of his friends. There is nothing even remarkable in the similarity of passages quoted, letting alone all questionable implications—nothing more than that vague "coincidence" which is constantly arising when two thinkers happen to be running upon the same track. Dr. Beard puts his most pointed illustration first. He quotes Mr. Spencer as saying: "We have had somewhat too much of the gospel of work. It is time to preach the gospel of relaxation." He then quotes from "American Nervousness," p. 313, his own expression, "The gospel of work must make way for the gospel of rest," and this he offers as a remarkable "coincidence."

But certainly no word is more stereotyped in universal usage than the term "gospel," as applied to views or doctrines which a party is engaged in propagating, from the gospels of the evangelists to Carlyle's "Gospel of Dirt," and the "gospel of dig" now discussed in the educational journals. The "coincidence" in the application of this word we should hold to be of a very innocent sort.

And here all coincidence ceases. The two gospels are not of the same kind. The two phrases "gospel of rest" and "gospel of relaxation" do not mean the same thing. Instead of being alike, their meanings are rather contrasted. We have simple passivity on the one hand, and activity of a given kind on the other. The "gospel of rest" is obeyed by inaction, by stopping work, or going to bed; while the "gospel of relaxation" implies rather a change of activity from work to play, and it connotes recreation, entertainment, and amusement. The "gospel of relaxation" means the substitution of agreeable diversion for tiresome labor. The Puritanical Sunday would answer to Dr. Beard's "gospel of rest," but it would not answer to Herbert Spencer's "gospel of relaxation." Dr. Beard's requirement was made into a gospel of duty by the ancient Jews; Mr. Spencer's requirement has as yet been made into a gospel of duty nowhere. The cases are, therefore, conspicuous for their lack of "coincidence," and the same thing will be observed in all the other counts.

The burden of Dr. Beard's pamphlet, as we have intimated, is to show that he was first in the field in the systematic treatment of "American nervousness"; and, as he entitles his pamphlet "Herbert Spencer on American Nervousness," the impression is sought to be conveyed that Mr. Spencer has recently entered upon a definite field of inquiry which Dr. Beard had made his own long ago. But in the first place the views of the two men are far from being of the same character, and, in the next place, Spencer's views are much older than those of Dr. Beard. As regards priority, it is only necessary to say that we heard Mr. Spencer give expression to the main ideas of his address long before the name of Dr. Beard was ever publicly heard of. It was an early outcome of his evolution studies, that, as in social progress the fighting dispensation of society gave way to the working dispensation, so the working dispensation must in turn give way and become subordinate to the higher objects to which work and wealth are tributary. The stage beyond, to which he maintains we are tending, will be characterized by a more perfect organization of the means of human enjoyment. That life is for pleasure in its largest sense is a cardinal idea of the Spencerian philosophy, and that the social fulfillment of this supreme end must come in practical forms, by giving larger and more systematic play to our pleasure-loving impulses and varied capacities of enjoyment, is an explicit and leading inculcation of Mr. Spencer's works. That completer living is to be attained by a multiplication of pleasurable satisfactions, and the perfected art of enjoyment was taught; for example, in his "Education," written twenty-five years ago, and the doctrine is at the basis of the "Data of Ethics," the most advanced treatise of his philosophical system. Mr. Spencer took up this cherished and long-familiar topic, in his New York address, simply because he was freshly and forcibly reminded of its importance by what he saw in this country.

History of the Pacific States of North America. Central America, Vol. I, 1501–1530. By Hubert Howe Bancroft. San Francisco: A. L. Bancroft & Co. Pp. 704. Price, cloth, $4.50.

This volume, the sixth in the great series of historical works by Mr. Bancroft, gives the history of the southernmost section of North America which borders on the Pacific, during the period of discovery and colonization previous to 1530. The first chapter, of a hundred and fifty pages, is introductory; half of it being devoted to "Spain and Civilization at the Beginning of the Sixteenth Century," and the rest to a "Summary of Geographical Knowledge and Discovery from the Earliest Records to the Year 1540." The summary includes a series of voyages by the Northmen to the northeastern shores of America, extending over five centuries; and mentions many expeditions both eastward and westward by travelers from Southern Europe, the earliest of these being made in 1096. The value of this account is increased by copies of fifteen maps drawn by the geographers of this period. In the second chapter, the continuous narrative of exploration and conquest begins with the first voyage of Columbus.

The author shows that the princes and navigators of this period had plenty of faults. The sovereigns of Spain joined to their zeal in increasing geographical knowledge, and in extending the domain of the holy Roman Church, a lively solicitude for their own power and revenue. The author finds, both from his study of Spanish authorities and from the admissions of Prescott, that Queen Isabella has been far too highly lauded by both Prescott and Irving. Even Columbus, who generally gets so much pity for the ungrateful treatment he received, is shown to have had weaknesses and faults which brought many of his misfortunes upon him.

The American natives do not suffer much from a comparison with their white conquerors. If they sometimes showed a thirst for Spanish blood, it was because the means employed to make them good Catholics and citzens were, to say the least, no gentler than those in use in the Old World. "They were more children than wild beasts. . . . . Seldom was the Indian treacherous until he had been deceived."

Mr. Bancroft has consulted many books and manuscripts in preparing this work, and the list of authorities quoted, which occupies forty-eight octavo pages, together with the references in the foot-notes on special topics, give the volume great bibliographical value. The numerous foot-notes give interesting details in regard to ships, trading, methods of administration, of dividing land, and of locating towns. The volume is well supplied with maps, and the chronicle is enlivened by many amusing and illustrative anecdotes.

Statement of Work done at the Harvard College Observatory, 1877–1882. By Edward C. Pickering, Director of the Observatory. Cambridge, Massachusetts: John Wilson & Son. Pp. 23.

The observatory has enjoyed for four years the revenue derived from an annual subscription of five thousand dollars. The last installments of the subscription expire in the present month, and an effort is now making to replace it with a permanent endowment of one hundred thousand dollars. The director calls attention to the fact that the increased amount of work made possible by the increased income is quite out of proportion to the augmentation of funds, because the expenses are largely the same in either case, and the increase is, therefore, directly available for scientific results. Fifteen assistants are attached to the observatory, and, by the division of labor rendered possible by so large a force, each man may be assigned the kind of work to which he is peculiarly adapted. In this way researches can be carried out in a few years which are beyond the reach of observatories where the corps of assistants is small.

Proceedings of the American Society of Microscopists. Fifth Annual Meeting. D. S. Kellicot, Secretary, Buffalo, New York. Pp. 292, with Plates.

The meeting of the society was held at Elmira, New York, August 15th to 17th last, under the presidency of George E. Blackham, F. R. M. S. The record contains a considerable number of papers of interest to specialists and students of microscopy, many of them well illustrated, of which two or three relating to organisms in Lake Erie and the water-supply of Buffalo and a memoir of Charles A. Spencer, the eminent maker of microscopes, deserve especial notice and are of more general interest.

Contributions to the Anatomy of Birds. By R. W. Shufeldt, M. D., United States Army. Washington, D. C. Pp. 210, including Twenty-four Plates.

This monograph is also embodied in the twelfth annual report of Professor Hayden's "Geological and Geographical Survey of the Territories," from which it is extracted. It contains descriptions, abundantly illustrated, of the osteology of the *Speotyto*, or burrowing owl; the *Eremophila Alpestris*, or horned lark; the *Tetraonidæ*, or grouse family; the *Lanius*, or Shrike; and the *Cathartidæ*, or buzzards.

Poems. By Minot J. Savage. Boston: George H. Ellis.

Mr. Savage sings his unpinioned thought and free religion as well as preaches it. Not that he has made a hymn-book for his Boston society, or can not pretermit, if need be, the professional function. Quite the contrary. There are many quiet poems in this collection pervaded by genuine humor, or with fine touches of feeling for nature and human life, which show that the author writes from the inspiration of true poetic art. But the poems that most interest us are those marked by the strong poetic expression of ideas and emotions with which the author's mind is "possessed." The poems entitled "Where is God?" "The Age's Unrest," "Infidelity," "Galileo," "Vanini," "Magellan," "Darwin," "Kepler," and many other pieces, although making up but a small part of the book, would well justify the title, "Songs of Modern Thought."

The Gospel of the Stars, or Primeval Astronomy. By Joseph A. Seiss, D. D., author of "A Miracle in Stone," "Voices from Babylon," "The Last Times," "Lectures on the Apocalypse," "Holy Types," etc. Philadelphia: E. Claxton & Co. Pp. 450. Price, $1.50.

This is an instructive book—instructive not because of the value of its information, but because it is an excellent representation of a certain phase of mind peculiar to these times, which springs out of the conflict of great adverse systems of thought. In the struggle of religion and science, which has been long developing, and is precipitated upon this age with much intensity, the fundamental question is, Which order of ideas—theological or scientific—shall predominate, and which take the subordinate place? It is now universally held that all truth is one. But, in the palpable issues that arise, unity can only be secured by some latitude of interpretation on one side or the other. Though all truth is one, the systems of belief are two, and there has got to be a yielding somewhere before the alleged unity can become a real unity. Men of science start with nature as it exists around them, and is open to exploration and the demonstration of its truths. And, when any system of thought is offered for acceptance, the men of science insist that it must be brought into conformity by interpretation with the order of truth established by science. Religious teachers, on the other hand—most of them, at least—start from theology, hold its doctrines to be in the ascendant, and demand that nature shall be interpreted in conformity with them as a subordinate system.

The work of Dr. Seiss is a thorough-going example of the dominance of theological ideas over scientific ideas. He, too, is engaged in the laudable work of reconciliation, but, like Hood's butcher, who "conciliated" his sheep by main force, our author reconciles science to theology by no little violence of interpretation. Its lesser details he knocks about without ceremony, and its larger conceptions he waves aside as illusions of not the slightest moment. Evolution, he declares, "*is a lie*," and, as this sufficiently illustrates, scientific truth has no weight with him. Steeped through and through with theological ideas, he can see nothing in the universe but his own system of divinity, while science is only useful as furnishing material to be twisted into conformity with theology, as he understands it. His book is pervaded with Scripture, and, both from the titles of the works he has formerly written and from the whole quality of this, it is seen that his mind is drawn to the mystical, the obscure, the enigmatic, cabalistic, and transcendental.

The special object of the present work is to show that "the true explanation of the origin and meaning of the constellations of the heavens, their figures and their names, as they have come down to us from the earliest ages of the human race," are only to be found in connection with Christian theology. It is commonly supposed that those fanciful celestial groupings of the stars into resemblances of animals, men, and other objects were devices of primitive times, before astronomical science had arisen. Herschel characterizes "those uncouth figures and outlines of men and monsters usually scribbled over celestial globes and maps" as "puerile and absurd." Dr. Seiss declares all this to be mere "rationalist conjecture," and solemnly maintains, on the other hand, that the constellations are pious intimations, illustrations, and witnesses of the scheme of salvation. The breadth of his view of the Christian system in the present year of grace is indicated by the following passage: "The gospel is chiefly made up of the story of the serpent and the cross—the doctrine of the fall and depravity of man through the subtlety of 'the dragon, that old serpent called the Devil and Satan, which deceiveth the whole world,' and the recovery of fallen man through a still mightier One, who comes from heaven, assumes human nature, and, by suffering, death, and exaltation to the right hand of supreme dominion, vanquishes the dragon, and becomes the author of eternal salvation. The preaching of this is the preaching of *the gospel*."

But the rubbishy erudition that seems necessary to understand this gospel, according to the present commentator, is something frightful. Certainly, if such a performance as this can pass muster, and the "Pastor of the Church of the Holy Communion, Philadelphia," has a rightful place in the Episcopal Church, Heber Newton has no business in the organization.

Moral Education, its Laws and Methods. By Joseph Rodes Buchanan, M. D. New York: S. W. Green's Son, 74 & 76 Beekman Street. Pp. 395. Price, $1.50.

Although this work, by its title, is limited to one phase of the great subject of education, and although the moral idea prevails throughout the exposition, yet the book is far from being a mere homiletic essay in the ordinary sense. The moral conception is dealt with in connection with many practical questions, so that there is a good deal of generality in the instructiveness of the treatise. Indeed, it is chiefly valuable from the breadth of the author's preparation for dealing with radical educational questions. Dr. Buchanan is an unfettered thinker, and his work is stamped with the individuality of his studies. He is, first of all, a physiologist—a student of man as a corporeal being, and he assigns to the subject of organization that fundamental place which it must hold in every rational system of culture, and which is beginning to be more clearly recognized in our own times than ever before. Yet the work is by no means and in no sense a physiological one, and the author is far enough from being a materialist. The truths of organic science are assumed rather than expounded, and on its basis and under its limitations the author deals with a whole range of the higher educational problems. No person interested in education can read the book without being helped by its information and its suggestions. It contains much of the philosophy of life, and many special problems that are now beginning to press upon teachers and educational managers are discussed with acuteness, ability, and much freedom from the restraints of tradition. It is impossible to enter here into any of the particular inquiries opened by Dr. Buchanan, and we have to confine ourselves to a general estimate of the character of the book. But, while very cordially commending it, the reader will not infer our agreement with all its views. We are all in that inquiring stage in regard to education which implies incompleteness of knowledge and a resulting diversity of opinion. We are working, it is to be hoped, toward a higher agreement, and such contributions as this of Dr. Buchanan are unquestionably valuable as means to this important end.

Fifteenth Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology. Cambridge, Massachusetts. Printed by order of the Trustees. F. W. Putnam, Curator. Pp. 103.

The trustees of the museum, in an appeal to the public last year, called attention to the fact that it is the only institution in the country especially for the preservation of collections and the study of American archæology, and that its income (the interest of $90,000) is only $4,500 a year. Its rooms, reasonably commodious and containing larger or smaller collections from different parts of the world—several hundred thousand specimens in all—are open free to visitors during business hours, and are supplemented with free descriptive lectures by the curator. The additions during the year include a valuable series of objects from the Ainos of Yesso (Japan), by Professor Penhallow; more than two thousand stone implements from Delaware, by Mr. H. R. Bennet; new objects, by Dr. C. C. Abbott, from his own collections in New Jersey, and exchanges from Ohio, Kentucky, and England; new specimens of the Wakefield (Massachusetts) stone implements in every stage of manufacture; potteries from Southeastern Missouri and Southern New Mexico, by

Mrs. S. B. Schlesinger; M. Bandelier's collections from the Pueblos and from Cholula, and Mr. Fred A. Ober's collection of copper implements from Oajaca, Mexico; specimens from English caves, and casts, by Mr. Dawkins; articles illustrating the making of pottery by the Caribs of British Guiana, from Professor H. A. Ward; soapstone pots from Northern Italy, by Dr. Emil Schmidt; and a cast of the "Endicott Rock" of New Hampshire. The curator carried on field-work at Madisonville, Ohio, and Indian Hill, Kentucky. More was done to make the museum and its objects known to the public, and more use was made of its collections for instruction and research, than in any previous year.

Lectures on Art. Delivered in Support of the Society for the Protection of Ancient Buildings. London: Macmillan & Co. Pp. 232.

The six lectures are by five authors, each of whom has devoted particular attention to the study of the subject he presents. The lecturers and their subjects are—Reginald Stuart Poole, on "The Egyptian Tomb and the Future State"; Professor W. B. Richmond, on "Monumental Painting"; Edward J. Poynter, R. A., on "Ancient Decorative Art"; J. T. Micklethwaite, on "English Parish Churches"; and William Morris, on "The History of Pattern Designing," and "The Lesser Arts of Life." The lectures are, one and all, interesting and instructive.

The Factors of Civilization, Real and Assumed: Considered in their Relation to Vice, Misery, Happiness, Unhappiness, and Progress. Vol. II. Atlanta, Georgia: James P. Harrison & Co. Pp. 359.

The whole work is to be in three volumes, of which the second precedes the first in time of publication. It treats of the subjects of more immediate and practical importance than those to be discussed in the first volume. The author maintains that man naturally inclines to goodness, and that all vice and misery arise from the operation of theological causes, bad government, ignorance, and poverty; or that the structure of society is defective because of defective institutions. Man, he holds, has a vital impulse to do implanted within him, which only requires that the institutions of society shall permit of its development, to create a growth "as grand in results as the magnificent oak bears in comparison to the insignificant acorn." The political economical factors of civilization are considered in this volume under the heads of "The Unhappiness arising from Poverty" and "The Unhappiness arising from Uncongenial Pursuits and Labor." The theological, governmental, and educational factors will be considered in the first volume; and the third volume will be devoted to "The Analysis of Happiness."

American Hero-Myths. A Study in the Native Religions of the Western Continent. By Daniel G. Brinton, M. D. Philadelphia: H. C. Watts & Co. Pp. 251. Price, $1.75.

This volume is an endeavor to present in a critically correct light some of the fundamental conceptions which are found in the native beliefs of the tribes of America. The author does not consider it creditable that so little has been done in this field, and is disposed to be severe, but hardly too much so, on those who have had opportunities to investigate the subject, and have not used them. He rejects the idea that the native myths are distorted historical reminiscences and exaggerated statements respecting persons that ever really existed, and has been guided by the principle that "when the same, and that a very extraordinary, story is told by several tribes wholly apart in language and location, then the probabilities are enormous that it is not a legend, but a myth, and must be explained as such." The myths of the lower races, he believes, "express, in image and incident, the opinions of these races on the mightiest topics of human thought, on the origin and destiny of man, his motives for duty, and his grounds for hope, and the source, history, and fate of all external nature. Certainly, the sincere expressions on these subjects of even humble members of the human race deserve our most respectful heed." With these views and in this spirit, Dr. Brinton presents the results of his studies, from the most authentic, accessible sources, of the hero-gods of the Algonquins, the Iroquois, the Aztec tribes, the Mayas, and the Quichas.

Report on the Character of Six Hundred Tornadoes. By Sergeant J. P. Finley, Signal Corps, U. S. A. Washington: Office of Chief Signal Officer. Pp. 19, with Three Charts.

The increasing frequency with which notices of tornadoes appear, as the list approaches the present time, is to be taken as a sign, not of more tornadoes, but of better observations. The season in which tornadoes appear most frequent is summer, and the month June. Spring is the next most frequent season, then autumn, then winter. The region most often visited includes the States of Iowa, Missouri, Kansas, and Nebraska, of which Kansas suffers the most. Outside of this region New York has the most tornadoes, and next, Georgia. Suggestions are given for avoiding the violence of tornadoes; many other lessons are derived from the study, and further ones are anticipated from further studies.

The December (or Christmas) number of "Wide Awake" is a noble magazine of 136 pages, with a supplement of 60 pages, filled with articles of high literary character and unexceptionable tendency. It is adorned with a profusion of illustrations, which, though executed in the best style of the present fashion in wood-engraving, can not be considered equal to the illustrations in the same magazine ten years ago, when a purer taste and a better style prevailed.

PUBLICATIONS RECEIVED.

*** *Authors and others, sending papers and monographs for notice, will please specify, for general information, where they can be procured.*

Dime Question-Books: General History, Astronomy, Mythology, Rhetoric, and Composition, Botany, with Notes, Queries, etc. Albert P. Southwick. Syracuse, New York: C. W. Bardeen. Pp. 36 to 40 each. 10 cents.

Iowa Weather-Service Annual for 1883. Gustavus Hinrichs. Central Station, Iowa City. Pp. 40.

Should American Colleges be open to Women as well as to Men? Frederick A. P. Barnard, President of Columbia College, New York City. Pp. 17.

Massachusetts Institute of Technology. Eighteenth Annual Catalogue, etc. Francis A. Walker, Ph. D., LL. D., President. Pp. 102.

The Taxation of the Elevated Railroads in the City of New York. Roger Foster. New York: G. P. Putnam's Sons. Pp. 61.

Apparent Attractions and Repulsions of Small Floating Bodies. John Le Conte. Berkeley, California. Pp. 10.

Medicine and Medicine-Men. Anniversary Address. John Godfrey. New Orleans, Louisiana. Pp. 17.

"The Sociologist: A Monthly Journal." Vol. I, Nos. 1 and 2. Adair Creek, Knox County, Tennessee: A. Chavannes & Co.

On the Loess and Associated Deposits of Des Moines. W. J. McGee, Farley, and R. Ellsworth Call, Des Moines, Iowa. Pp. 24.

Circulars of the Department of Education: High-Schools for Girls in Sweden, pp. 6; Instruction in Moral and Civil Government, pp. 4; National Pedagogic Congress of Spain, pp. 4; Natural Science in Secondary Schools, pp. 9; The University of Bonn, pp. 67; Proceedings of Department of Superintendence of the National Educational Association, 1882, pp. 112. Washington: Government Printing-Office.

The Naval Use of the Dynamo-Machine and Electric Light. Lieutenant J. B. Murdock, U. S. N. Annapolis, Maryland. Pp. 385.

"Census Forestry Bulletin," No. 23—Estimate of the Consumption of Forest Products as Fuel during the Census Year. P. 1, with Map.

Department of Agriculture—Report of the Entomologist, 1882. C. V. Riley. Washington: Government Printing-Office. Pp. 104, with Plates.

The Condition of Niagara Falls, and the Measures needed to preserve them. J. B. Harrison. (Author's address, Franklin Falls, New Hampshire.) Pp. 62.

"The Reconstructionist: Devoted to the Substitution of Good for Evil." Samuel T. Fowler. Quarterly. Philadelphia: George A. Fowler & Co. Pp. 64. 25 cents.

A Method of Teaching the Greek Language Tabulated. John W. Sanborn, Batavia, New York. Published by the author. Pp. 44. 30 cents.

Statistical Report of Imports, Exports, Immigration, and Navigation, for the Three Months ended September 30, 1882. Washington: Government Printing-Office. Pp. 157.

Hospital Accommodations of County Poor-Houses. Dr. Charles S. Hoyt, Secretary, New York State Board of Charities. Albany, New York. Pp. 53.

Bromide of Ethyl (as an Anæsthetic). Julien J. Chisholm, M. D. Baltimore, Maryland. Pp. 8.

Report of an Exploration of Parts of Wyoming, Idaho, and Montana, in August and September, 1882, made by Lieutenant-General Sheridan. Washington: Government Printing-Office. Pp. 69.

"Journal of Social Science." December, 1882. A. Williams & Co., Boston, and G. P. Putnam's Sons, New York. Pp. 178. $1.

Report of the Standing Committee, New York State Board of Charities, on County Poor-Houses. Pp. 8.

On the Geological Effects of a Varying Rotation of the Earth. Professor J. E. Todd. Pp. 12.

"Scientific Proceedings of the Ohio Mechanics' Institute." Quarterly. December, 1882. Cincinnati, Ohio. Publishing Committee, Ohio Mechanics' Institute. Pp. 48. $1 a year.

The Place of Original Research in College Education. J. H. Wright, Dartmouth College, Hanover, New Hampshire. Pp. 29.

Mutual Relations of Intellectual and Moral Culture. Joseph Le Conte. Berkeley, California. Pp. 7.

General Weather-Service, United States. "Monthly Weather Review," November, 1882. Washington, D. C.: Office of the Chief Signal-Officer. Pp. 21, with Maps.

Papers of California Academy of Sciences on "Footprints found at the Carson State-Prison" (H. W. Harkness, M. D., Joseph Le Conte, C. D. Gibbs); on "Fossil Jaw of a Mammoth" (C. D. Gibbs); and on "Fresh-water Mussels" (Robert E. C. Stearns). San Francisco, California. Pp. 58, with Plates.

Science Ladders: Lowest Forms of Water Animals. N. D'Anvers. New York: G. P. Putnam's Sons. Pp. 59. 50 cents.

First Year Manual and Text-Book of Arithmetic. James H. Hoose. Syracuse, New York: C. W. Bardeen. Pp. 156. 50 cents.

A Practical Arithmetic. G. A. Wentworth and Rev. Thomas Hill, D. D., LL.D. Boston: Ginn, Heath & Co. Pp. 351.

Notes on Ingersoll. Rev. L. A. Lambert. Buffalo, New York: Buffalo Catholic Publication Company. Pp. 184. 50 cents.

Herbert Spencer on American Nervousness. George M. Beard, M. D. New York: G. P. Putnam's Sons. Pp. 17. 50 cents.

Political Economy. Francis A. Walker. New York: Henry Holt & Co. Pp. 490. $2.25.

Introduction to the Study of Organic Chemistry. Adolph Pinner. Translated and revised by Peter T. Austen. New York: John Wiley & Sons. Pp. 403. $2.55.

Catalogue and Index of the Publications of the Smithsonian Institution. William J. Rhees, Washington, D. C. Smithsonian Institution. Pp. 328.

Slight Ailments; Their Nature and Treatment. Lionel S. Beale. Philadelphia: P. Blakiston, Son & Co. Pp. 283. $1.25.

The Cause of Variation. M. M. Curtis. Marshall, Minnesota: Published by the author. Pp. 115.

Report of the Chief Signal-Officer, War Department, 1880, pp. 1,120, with 119 Charts. The same, 1881, pp. 1,296, with 59 Charts. Washington: Government Printing-Office.

POPULAR MISCELLANY.

Experimental Demonstration of Ohm's Law.—An interesting experimental demonstration of the truth of Ohm's law was recently given by Professor Alfred M. Mayer, of the Stevens Institute of Technology, before the New York Electrical Society. This law, as is well known, affirms that in any electrical circuit the current flowing varies directly as the electro-motive force and inversely as the resistance, or, in symbols, $C = \frac{E}{R}$, where C is the current, E the electro-motive force, and R the resistance of the entire circuit, including that of the generator. To demonstrate the truth of this law, it is only necessary to show that, the resistance remaining constant, the current increases in the same ratio as the electro-motive force when this is augmented; or that, the electro-motive force being maintained constant, the current varies in the same ratio as the resistance as this latter is raised. In Professor Mayer's experiments the current was measured by means of a Thompson reflecting galvanometer—a delicate instrument in which the deflections of the needle are multiplied to any desired extent by means of a beam of light, reflected from a small mirror attached to the needle, which is received upon a screen. The novel feature of Professor Mayer's demonstration consisted in his mode of obtaining the current so that the electro-motive force could be known with great accuracy, and readily varied. This consisted in generating it by means of the movement of a coil of wire along a bar-magnet. The electro-motive force of the current so produced depends upon the number of lines of magnetic force cut by the moving coil in a unit of time, so that this can be varied by varying the speed with which a given coil is moved, or, the speed remaining the same, by varying the number of coils. Professor Mayer resorted to the latter measure, his apparatus consisting simply of an upright bar-magnet over the end of which a loop of wire could be slipped, the distance which this could slide being limited by a stop. The movable coils consisted of the same lengths of copper wire, in which there were taken one, two, or more loops, the resistance of each of these pieces being the same, so as to maintain that of the complete circuit constant. The coils were placed over the upper end of the magnet, and carried down until they rested upon the stop, the needle of the galvanometer brought to the zero of the scale, and then the coil pulled off the magnet with a quick motion. The deflection of the needle indicated a variation in the current in proportion to the number of loops of wire used, and when the resistance was varied in proportion to the amount of this variation. A better form of the apparatus is one in which the coil, instead of being moved by hand, is drawn up quickly by a spring, when it is released by the pulling of a trigger. With this, Professor Mayer is at present studying the development of magnetism in electro-magnets.

More about the Lignified Snake.—Doubts are expressed, in a paper recently read by Professor C. V. Riley before the Biological Society of Washington, as to the so-called "lignified serpent" of Matto Grosso, Brazil, which was described and illustrated in the November number of the "Monthly," being really a serpent at all; Professor Riley rather believes the formation to be the burrow of the larva of some beetle, filled up with excrement and rudimentary fiber, as such burrows commonly are filled. In support of his view he makes the points: that the object in advance of the so-called reptile's head to the unimaginative eye appears, not like an insect larva, but like a simple knot, similar to two knots which appear in the body of the more prominent formation; that the diameter of the formation is greatest at the point where the relief ends, as would be the case with a larva eating its way from the point corresponding with the "head" of the "serpent" and growing as it advanced toward the "tail"; that the first curve, which, on the serpent theory, the animal must have made in forcing its way under the bark, is so abrupt and the relief so doubled upon itself that a snake could not make such a bend without breaking its vertebræ; that the cephalic plates and scales are imaginary; that the curves shown, though natural to a burrowing larva, are not natural to a snake forcing itself into so confined a space; that the woody formation of the relief indicates a burrow beneath the larva, and not the forcing of anything between the bark and the wood, for such forcing would have loosened the bark for some distance on either side of the relief, and a forcing of the kind supposed could not take place without interference with the growth or soundness of the tree; that the granular appearance to be seen along the sides of the specimen and the fibers observable are just such as an insect-larva would leave, and can not be accounted for on M. Ollivier's hypothesis; that the animal matter in the center of the body may be accounted for as arising from the exuviæ and excrement of the larva; and that the work of human hands in heightening resemblances, particularly about the head and eyes, can be detected. The whole question, finally, could be readily settled by careful section, which would show traces of vertebræ or phosphate of lime along the vertebral line if there really were a serpent. Professor Gray, in the January number of the "American Journal of Science," suggests two explanations as more probable than that which depends upon the snake. One is, that the snake-like body is of the nature of a root, an aërial root, like those of a *Clusia* or a *Ficus*, which was making its way between bark and wood, and that the supposed larva is an incipient root of the same kind. The other, which was proposed by Professor Wadsworth, of Cambridge, while examining the specimen along with Professor Gray, "and is to be preferred," "supposes that the sinuous course is the track of a wood-eating larva or some kind of insect, the burrowing of which had not destroyed the overlying fiber; consequently the new growth filling the space (except at certain points) had naturally assumed the likeness of a snake."

Vital Conditions affecting the Colored Population.—Dr. S. S. Herrick, Secretary of the Louisiana State Board of Health, presented facts and tables at the Savannah meeting of the American Public Health Association, showing that, as between the two races, the rate of mortality for all ages is invariably much greater among the colored than among the white, and that the disparity is more marked in the case of children under five years of age. The colored race appears to enjoy an advantage in malarial fevers and cancerous diseases, while it is at a disadvantage in all the other diseases. Mr. Patterson's tables, exhibiting the increase by decades of the colored population in the United States, given in "The Popular Science Monthly" for September, 1881, show that the rate of increase during the decade, including the war, fell off by sixty or seventy per cent. The rate was, however, brought up to near its highest figure in the returns of the last census. The last fact is held by Dr. Herrick to correct the belief that the African race is destined to disappear in the struggle for existence. "Apparently, this race is increasing more rapidly than its white compatriot." The fact, however, which seems to have been overlooked, should be borne in mind, that the mulattoes and quadroons are all reckoned as colored, so that the increase is partly due to the whites. If the rapid increase of the colored race proves anything, it is that there is plenty of room yet for that class of people. This leads to the consideration of what will probably be the future of the colored people when they are crowded upon. "Whatever may be the capacity of the race for development in a state of peace, it is apparent, from the great check on their increase between 1860 and 1870, by the operations of the civil war, that any serious disturbance of their industrial pursuits, like a prolonged foreign war or political convulsions at home, would produce such distress as to disturb profoundly their vital movements. The same event would follow an over-production of the staples grown by their labor, owing to their habitual improvidence. Thus far they have experienced no serious rivalry, and therefore no check to their natural increase. . . . This fact is undoubtedly favorable to the numerical increase of the race, though it is equally clear that it tends at the same time to delay its intellectual improvement by deterring individuals from pursuing other and higher industries. In any event, there is little danger that either race will severely encroach on the ground of the other in our time, and no danger that the colored population of any part of the country will be in the way of the whites, unless they should so far advance intellectually and morally as to win a commanding position by sheer force of merit."

Northern Transcontinental Survey.—A "Northern Transcontinental Survey" has been organized in the interest of the Northern Pacific Railroad and its allied lines, under the direction of Mr. Raphael Pumpelly, the purpose of which is to obtain a satisfactory knowledge of the extensive, hardly explored regions which may be made tributary to those lines and their resources. It has been divided into departments of mineral resources, climate, rivers and irrigation, soils, forests, economic botany, laboratory, and topography, which have severally been put in charge of specialists. A considerable amount of preliminary work was done last year, the most important, perhaps, of which related to the examination of the black coals of the western part of the region under survey and of the brown coal-fields of Dakota. The former coals were found to be good steam-generators, the latter not, except in combination or after special preparation. Particular attention is paid to the forest resources of the country, in which we are glad to see that the economical use of the timber is not wholly left out of sight; and observations are making on the useful grasses of the country. The results of the surveys are to be cartographically represented, in a series of maps delineating severally topographical, hydrographic, climatic, and botanical features.

Langley's Observations on Solar Radiation.—The scientific expedition of Professor S. P. Langley, of the Alleghany Observatory, to the summit of Mount Whitney, in 1881, has led to some important and novel conclusions with reference to the effect of the atmosphere on the action of the sun's rays, and to the temperature of space. Among the principal objects of the expedition were, to determine how much heat the sun sends to the earth (the solar constant), and what part of the surface temperature of the planet is due to the sun's direct radiant heat, and what part to the effect of the earth's atmosphere in storing this heat. Mount Whitney, in Southern California, was chosen, because of the conveniences afforded by its great height and the dryness of its atmosphere, and because two stations could be found upon it within easy signaling distance, and yet having a difference of more than eleven thousand feet in elevation. One of the earlier observations of the expedition was to notice, as former observers had done, "that as we ascended, and the air grew colder, the sun grew hotter, till our faces and hands, browned as they already were by weeks of sunshine below, were burned anew, and far more in the cold than in the desert heat. As we still slowly ascended, and the surface temperature of the soil fell to the freezing-point, the solar radiation became intenser, and many of the party presented an appearance as of severe burns from an actual fire, while near the summit the temperature in a copper vessel, over which were laid two sheets of plain window-glass, rose above the boiling-point, and it was certain that we could boil water by the direct solar rays in such a vessel among the snow-fields." This observation induced the conclusion that if the earth's atmosphere were withdrawn, the temperature of the surface would greatly fall, though under a materially greater radiant heat; and Professor Langley expresses the opinion that the fall would be at least to 50° below zero of Fahrenheit. "We see," says Professor Langley, "if these results be true, that the temperature of a planet may, and not improbably does, depend far less upon its neighborhood to or remoteness from the sun than upon the constitution of its gaseous envelope; and, indeed, it is hardly too much to say that we might approximately indicate the constitution of an atmosphere which would make Mercury a colder planet than the earth, or Neptune as warm and habitable a one." A much greater value than has hitherto been accepted appeared to be given by the observations to the solar constant, amounting to one half more than that determined by Pouillet and by Herschel near the sea-level, and even to more than the recent values assigned by M. Violle. The bolometer observations at the summit and base of Mount Whitney indicate a different distribution of solar energy at the upper station from that which prevails at the lower one. They also indicate, as the author states in a communication to the French Academy of Sciences, that only one quarter of the solar energy which vivifies the world is found in the familiar field of the visible spectrum and the ultra-violet; and that the other three quarters are found in the infra-red. Thus the action of our atmosphere, and, as is inferred from the observations, that of the solar atmosphere, is to absorb the short rays more than the long ones. The real color of the photosphere is blue; and "white light is not the 'sum of all radiations,' nor even of all visually recognizable ones, but a composition of the small groups of special rays, which, starting from this essentially blue sun, by virtue of their large coefficients, and by a kind of survival of the fittest, have struggled through the solar and terrestrial atmospheres to us, while others of short wave-length have failed on the way."

Infectious Consumption.—Dr. Alexander McAldowie has considered the much-debated question whether pulmonary consumption is an infectious disease in the light of his own infirmary and private practice. He is of the opinion that it is infectious, although it is not so frequently communicated by infection as it would be were the lungs less well protected than they are against the access of germs. He mentions four cases where the wife, previously healthy, and with no family history of tubercular disease, became affected while attending to her phthisical husband, and two cases in which persons suffering from the pneumonic form of the disease appeared to communicate the tubercular form to healthy persons. Phthisis is not often communicated in this manner by ordinary intercourse, because the germs are sifted out in the air-passages by the vibrating action of the cilia situated there, and are removed by expectoration. The germs floating in the air are, moreover, commonly dry, and of feeble infective power. The lungs are liable to infection only when the inhaled germs escape the filtering action of the bronchi and reach the air-cells, where they come in contact with a surface highly favorable for their absorption. This happens only under exceptional conditions. The parts of the alveoli most exposed to the attacks of inhaled germs are those near the entrance, at the points where the small bronchial tubes lose their cylindrical character and become covered on all sides with the cells; and pathological observation has proved that these are frequent starting-points in phthisis.

Subterraneous Effects of Atmospheric Pressure.—Hardly sufficient account has been taken of the variations in the pressure of the atmosphere as a force competent to produce important effects within the earth and on its surface. The pressure on a man's body amounts to thirty thousand pounds, and that exerted upon a table ten feet long and five feet wide is equivalent to more than one hundred thousand pounds. In both these cases the pressure varies alike on all sides, and changes are not directly felt; but the cover of an air-tight box, the pressure in the interior of which could not vary, would act very differently, and would respond to the slightest changes. The crust of the earth probably — certainly where cavities exist—is like such a cover. The consideration of this fact may help to explain the connection which many persons think they have found between earthquakes and coal-mine explosions and low stages of the barometer. A part of the weight of the atmosphere being removed, the gases confined within the earth exert a stronger pressure on the crust, or flow out and are inflamed when they reach a light. Mr. Baldwin Latham has found that the streams flowing through the chalk, even in dry seasons, give increased supplies of water when the barometer is falling, and diminished supplies when it is rising.

Mental Shock and Inebriety.—Dr. T. D. Crothers, Superintendent of Walnut Lodge, Hartford, Connecticut, has a paper in the "Quarterly Journal of Inebriety," the object of which is to show how psychical traumatism, or injury from mental agitation or powerful emotion, an agency whose operation is not generally recognized, is often an active cause of inebriety. He marks two distinct periods in all cases of inebriety, the first of which, beginning somewhere in the past, is unknown and not noticeable to ordinary observers, and terminates with the first excessive use of alcohol. The second period starts from this point, is noted by the occasional or continuous excessive use of spirits, is terminated only by recovery or death, and is the period which comes under the observation of friends and relatives, and can be accurately studied. The causes and conditions in the first, or neurotic stage, are often as varied and complex as those which produce insanity, and often, notwithstanding their obscurity, present distinct intimations of inebriety far in advance. "A certain progressive march may be noted, often broken by long obscure halts or precipitous strides, changing into various forms and manifestations of disease. The neurotic stage will be marked, in most cases, by nerve exhaustion, instability of nerve-force, and nutrient perversions. Not unfrequently delusions and hallucinations about foods and drinks are unmistakable symptoms. Often persons who have never used spirits, and become fanatical in their efforts to reform inebriates, are in this stage, and sooner or later glide into the next one." Psychical traumatism may be considered both as a direct cause of inebriety and as an indirect cause, as which it develops conditions that rapidly merge into the disorder. A number of incidents that have come under the author's observation, some of which are extremely striking, are given as illustrative of its operation from both points of view. In all of them inebriety has immediately or gradually supervened in persons who would have been the last to be suspected of liability to it, after some intense mental shock or surprise or information of disaster. The usual explanation of such cases, says Dr. Crothers, would be that the victims drank from despair and discouragement, "but a general study will show a state of psychical pain and agony for which alcohol alone acts as a sedative. It very commonly appears, in a study of cases of inebriety, that the patient will refer to some event of life, or disease, from which he is confident that he lost some power or force which he has never regained. These incidents do not come out as reasons for his drinking, but as facts pertaining to his vigor or power of endurance." Such cases of loss of power are found in every community, "and of course do not all become inebriates, but, like a large class of eccentrics, are on the border-line, or inner circle, shading into inebriety or insanity. A large number of persons engaged in the late civil war, who suffered hardship and mal-nutrition, became inebriates years after, following the psychical and physical traumatism received at that time. The effects of commercial disasters, of bankruptcies, and panics in Wall Street, can be seen in inebriate or insane asylums. In the asylum at Binghamton, New York, for inebriates, at one time were eighteen cases whose inebriety could be clearly traced to a great money-panic in Wall Street known as 'Black Friday.' Many of these cases were purely from psychical traumatism, others were already in the dark circle close to inebriety, and needed but a slight cause to precipitate them over. Political failures are also fertile fields for the growth of inebriety and the action of psychical influences. Annually a large class, after the close of a campaign, find themselves literally inebriates, and, if they have money, go to water-cures, inebriate asylums, or to the far West, and begin life again. The inebriety is often of the paroxysmal or dipsomaniacal type, with free intervals of sobriety that give renewed energy to the delusive hope that recovery will follow the bidding of the will. A class of moderate or occasional drinkers are always more susceptible to these influences than abstainers"; and it may be stated as a rule that moderate drinkers suffer more frequently from psychical shocks of every form, and are more likely to become inebriates from such causes.

The Poison of Cesspools.—M. Bouveret has reported on a remarkable case of poisoning from a cesspool which took place at Lyons. A workman, twenty-one years old, having fallen into a cesspool, was taken out, after having been in it about five minutes, in a state of convulsions. Inhalations of oxygen were administered for several hours, but the convulsions continued with rise of temperature. Transfusion of blood (defibrinated) was then tried without effect, and death took place about twenty-four hours after the accident. The blood was found, on *post-mortem* examination, to be black and fluid, the lungs and kidneys were congested, and the bronchial mucous membrane showed a bright hyperæmia, but no coagulation was observed in the pulmonary artery. The chief toxic agent in the contents of cesspools is supposed to be sulphide of ammonium, a poison which acts on the blood in the same manner as carbonic oxide, deoxidizing the red globules and making them unfit to perform their functions. Transfusion of blood has been performed with success in cases of poisoning by carbonic oxide, and its failure in the present case has provoked the suggestion that cesspools may contain gaseous poisons far more complex and more virulent than sulphide of ammonium, the action of which is more profound and complicated.

Ancient Maya Records.—Dr. Daniel G. Brinton, of Philadelphia, has recently come into possession of a number of *fac-simile* copies of the Books of Chilan Balam, or the local records of the Mayas of Yucatan, and has published an interesting account of their character and contents. The name, "Book of Chilan Balam," was applied to all the works of this character, to whatever village they might belong, and the different ones were distinguished by adding the name of the village. Only a few of the original volumes remain, most of them having been destroyed by the priests as heretical and mischievous; but a few were afterward compiled over again by natives from their own knowledge and recollections. Parts or descriptions of sixteen of these works remain, not one of which has ever been printed, or even entirely translated into any European tongue. Their contents consist chiefly of astrological and prophetic matters, ancient chronology and history, medical recipes and directions, and, in the later ones, later history and Christian teachings. One of the most valuable features in these records lies in the hints they furnish of the hieroglyphic system of the Mayas, concerning which our only information has hitherto been in the essay of Bishop Landa. Some features of Bishop Landa's notes on this subject have been condemned by Dr. Valentini, as we have already mentioned, as "fabrications," but Dr. Brinton pronounces Dr. Valentini's attack "an amount of skepticism which exceeds both justice and probability," and he believes that the result of a comparison with the hieroglyphics of the books of Chilan Balam and of the Codex Troano will refute the doubts and slurs that have been cast on the bishop's work, and "vindicate for it a very high degree of accuracy."

Lessons on the Danger of Narcotics.—The deceased poet, Dante Gabriel Rossetti, was a victim of chloral, which he took for sleeplessness, with the inevitable result. About 1868, his friend Mr. Watts says, in the "Athenæum," he was attacked with insomnia, one of the most distressing effects of which as manifested in him was "a nervous shrinking from personal contact with any save a few intimate friends. This peculiar kind of nervousness may be aggravated by the use of sleeping draughts, and in his case was thus aggravated. . . . No man ever lived who was so generous as he in sympathizing with other men's work, save only when the cruel fumes of chloral turned him against everything." Another conspicuous warning against the use of narcotics is given in the case of the death of Dr. Thomas Atkinson Elias, a physician of Southport, England, under circumstances which led the coroner's jury to believe that it was caused by an overdose of morphia. It was shown at the inquest that he was occasionally troubled with sleeplessness and frequently took for it morphia, chloral, nepenthe, or bromide of potassium. It is lamentable, says the "Lancet," to see medical men drift into such uses of drugs, which engender the very evils for which they are taken, and are so apt to issue in results quite uncontemplated. "Such evils are to be cured, and meantime borne with patience, not met by dangerous medicines in random doses."

Mechanical and Vital Education.—"Some dangers of education" are treated with much intelligence in a thoughtful essay in the "Saturday Review." One of the dangers relates to the difference between what may be called mechanical and vital education. By mechanical education is meant "the imbuing the mind with those elements which can be taught by pure rule; in which no demand is made on the child or youth beyond attention and industry; into which the element of choice on his part does not enter. Such elements there are in every subject." Among them are the teaching of the alphabet, of the pronunciation of written words or syllables, of spelling, of writing, of the multiplication-table, of rules for the addition or subtraction of fractions, of many other arithmetical processes, and, in the higher subjects, the inculcation of the Greek and Latin grammar and vocabulary, of the propositions of Euclid, of historical dates and facts, and of many elements in the most difficult branches of learning, the processes of which are mechanical and nothing more. "But in all sound education these mechanical rules are never treated as an end in themselves, nor again as a mere stepping-stone to other mechanical rules of a more difficult kind. They are, each and all of them, keys to unlock the several successive chambers of the world in which we live; and, whether the treasures stored up in those chambers are of a material or spiritual kind, . . . the unfolding of these several treasures is not in any way a mechanical, it is a vital process. And here a totally new element comes in on the part of the student. It is no longer with him a matter of attention only; he will begin to exercise choice. It is found by experience that boys and girls are not incapable of taking interest in the world in which they live; but no prescribed plan for creating such an interest in them is possible. Thousands of interesting topics may be unfolded before the eyes of a boy, and he will have none of them: at last something occurs which touches him; curiosity or sympathy is awakened; and from that moment he takes an initiative, his vital education is on the move. And from that moment the mechanical inculcation of rules ought to be somewhat relaxed; not that it may not still be necessary sometimes, but it ought not to be suffered to interfere with the more important element—the spontaneous pursuit of knowledge, the spontaneous feeling of sympathy with men. Now, here is the delicate, the critical point in education, the point at which the teacher or the educational authority has such serious difficulties to contend with in making a decision. . . . There is a proper medium in the enforcement of the mechanical part of education: if it is enforced too little, there is the mischief attendant upon idleness on the child's part, besides the loss of the use of a valuable instrument; if it is enforced too much, vital energies will be quenched, and the whole result will be dry and formal." The tendency in the primary schools, and of all formal competition in the higher schools and universities, is to produce mechanical rather than vital excellence.

NOTES.

Dr. Charles M. Culver, of West Troy, a graduate of Union College and of the Albany Medical College, has been making the study of the eye a specialty under the guidance of eminent professional men in London, Berlin, and Paris, and is now an assistant of the celebrated oculist, Professor Landolt, at the French capital. Dr. Culver is at present engaged in translating from the French into English the treatise on "The Refraction of Light," by Professor Landolt, which forms the second volume of the comprehensive work on "Ophthalmology" by Wecker and Landolt. It will be an interesting contribution to our scientific literature.

Dr. George M. Beard, a physician well known for his investigations in nervous disorders, and the contributor of several articles to "The Popular Science Monthly," died in this city, January 23d, at the age of forty-three years.

Mr. G. W. Tinsley, of Columbus, Indiana, has suggested a new theory of the operation of solar and lunar gravities in producing the tides. The tide on the side of the earth nearest to the attracting bodies is induced by the acceleration of the rotation of the waters on that side causing them to rush up toward the point of greatest attraction. The tide on the opposite side is due to the formation of an axis of gravity by the combined attractions of the earth and moon, around the pole of which the water accumulates; in the same manner as if, when we had a fluid substance that a magnet would attract, and were to fill a vessel with it and hold a magnet under the vessel, we might expect the substance to accumulate to a greater depth immediately over the magnet than elsewhere.

The Rev. James Challis, Plumian Professor of Astronomy, and Fellow of Trinity College, the senior of the professors at the University of Cambridge, died early in December, in the eightieth year of his age. He had actively discharged the duties of his professorship from 1836, when he was appointed to succeed Professor Airy, till within two years of his death. He published a considerable number of scientific works, including twelve volumes of astronomical observations.

The "Moniteur Industriel" says that electrical force is regularly installed as the propelling power of the trains on the three railroads from Lichterfeld to Spandau, Prussia; from Port Bush to Busa Mills, Ireland; and from Zandvoort to Kostverloren, Holland. Electrical railway lines are in construction from Wiesbaden to Neroberg, Prussia; at Zankerode, in Saxony; a subterranean and subfluvial road in London; and one in South Wales, the motive power for which is derived from a fall of water. Of lines projected are the urban railways of the cities of Milan and Turin; the Edison Company's projected line in the United States; and the South Austrian Company's line.

Signor Antonio Favoro is about to publish a work on the career of Galileo while he filled the chair of Mathematics in the University of Padua, from 1592 to 1610, a period of Galileo's life concerning which little has been hitherto published. It will contain about a hundred and fifty documents, for the most part unedited.

Sir Woodbine Parish, a venerable English diplomatist, a former vice-president of the Geological and Geographical Societies, and author of a work on the "Natural History of Buenos Ayres and the Rio de la Plata," died recently, in the eighty-sixth year of his age. He was also known to the scientific world for having taken to England the remains of the megatherium, glyptodon, and other great South American fossils.

The death is announced of Andrea Aradas, of Catania, Sicily, a laborious student of marine zoölogy and paleontology, whose numerous publications extended over a period of forty years.

The Peabody Museum of Archæology has acquired a collection of contemporary potteries in various stages of manufacture, and pottery-making tools, of the Caribs of British Guiana, which were bought in person several years ago by Professor H. A. Ward from a Carib woman whom he was watching make earthen vessels. Among the articles were several small and rude vessels which Professor Ward saw the Indian woman form and give to her children to play with and amuse themselves while she continued her work. These toy-vessels suggest that many of the small objects of similar character found in mounds and graves may have been the playthings of children.

Dr. Gustave Svanberg, formerly Professor of Astronomy and Director of the Observatory of the University of Upsala, Sweden, died November 21st, in his eighty-first year.

One of the largest brains on record is that of an illiterate, not very intelligent mulatto, of Columbus, Ohio, who recently died at the age of forty-five years, and whose case is reported by Dr. Haldeman in the "Cincinnati Lancet." His brain weighed $68\frac{3}{4}$ ounces, or nearly five ounces more than the famous brain of Cuvier. The case was mentioned, in our December number, of a bricklayer who could neither read nor write, whose brain weighed 67 ounces.

The death of the Marquis Orazio Antinori, the distinguished zoölogist and African traveler, is reported from Aden. He had just started, at seventy-one years of age, on a new expedition to the Upper Nile.

One of the strongest evidences that practical education is destined hereafter to receive a fairer share of attention at the old universities is afforded by the fact that a course of lectures has been begun at Cambridge, under Professor Stuart, "On the Practice of Iron and Brass Founding, with Practical Demonstrations in the Foundry."

M. Palmieri, Director of the Observatory on Mount Vesuvius, announces that he has discovered, in the lava of that volcano, a spectrum line corresponding to that of helium, the element whose spectrum has hitherto been found only in the sun.

The French Academy of Sciences presented M. J. B. Dumas, the chemist, on the 4th of December, a gold medal, in commemoration of his having reached the fiftieth year of his membership of the body. M. Jamin, representing the Academy, expressed wonder that it had only taken fifty years to do as much as M. Dumas had accomplished.

INCREASE ALLEN LAPHAM.

THE

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NATURE AND LIMITS OF THE SCIENCE OF POLITICS.

By Professor SHELDON AMOS, LL. D.

THE progress of the strictly physical sciences in modern times has had a twofold influence on the advancement of those branches of knowledge which deal less with physical than with moral, social, and political facts. On the one hand, the exact methods and indisputable conclusions of the sciences concerned with matter have inaugurated modes of study and inquiry which are believed to be of universal application. On the other hand, the standard of rigorous logic in all studies is so far exalted that those subjects of thought or investigation which do not conform to identically the same standard as that maintained for the study of matter are thought to be not worth pursuing with any regard to the claims of a severe logical process. This sort of antipathy between the physical and the ethical regions of search and argument has been intensified by the co-existence of two opposed orders of minds, the ardently speculative and the persistently practical. The former are discontented with the notion of a so-called Science of Politics, because of the complexity of the subject-matter, and the intrusion, at all points, of such seemingly incalculable factors as the will and passions of mankind. Practical statesmen, again, immersed in actual business, and oppressed by the ever-recurring presence of new emergencies, almost resent the notion of applying the comprehensive principles of science, and still more the conjectural use of foresight, in respect of subjects which, for them, are in ceaseless flux, and can, at best, only be safely and wisely handled by momentarily adjusted contrivances.

Between these two extreme classes lies all the large portion of society composed of persons with minds less distinctly determined and trained in one direction or the other, and therefore all the more open to be impressed by influences derived from sound thinkers and energetic workers, but experiencing these influences only in a loose and diluted form. The aggregate result is that the subject of Politics floats in the public mind either as a mere field for ingenious chicane or as a boundless waste for the evolutions of scholastic phantasy. If Politics are to be vindicated from the aspersions cast upon them from the opposite quarters here indicated, and are ever to be erected into a science, with its own appropriate methods and limitations, the foundation of these skeptical suspicions must be investigated and their real value strictly assessed. The investigation will proceed as follows:

1. One obvious class of objections to the possibility of applying rigorous scientific methods to Politics is founded on the number and nature of the component and preparatory studies which are presupposed in all strict inquiries into the theory of government. Assuming that the physical sciences—beginning (say) with astronomy and ending with physiology or psychology—have reached a strictly scientific stage, there yet remain, as properly leading the way to the study of Politics, all those branches of knowledge which depend on the composite nature of man both as isolated and as in society. Such are Ethics in the Aristotelian sense, comprehending as topics decorum and propriety as well as duty; political economy, which deals with the conditions under which national wealth is produced, accumulated, and distributed; law and legislation (sometimes comprised under the general head of jurisprudence), which deal with the essential nature, logical distribution, and historical growth of the general rules of conduct which all governments maintain and enforce; and, lastly, the somewhat novel science of Sociology, which deals with the inherent problems to which the aggregation of mankind into groups gives rise, so far as these problems can be abstracted and treated independently of government.

This list of studies, which might be multiplied and varied to any extent according to individual proclivities, incloses large areas of knowledge over the subjects of which the human will and human passions must have, at least in the course of ages, and in passing from country to country, an amount of influence which seems to set scientific precision at defiance. Nevertheless, and in spite of all the controversies waged among those who prosecute these studies, there is no doubt that in all these pursuits the most searching and exact methods, so far as they are applicable, are beginning to be used, and the certainty and universality of the sequence of cause and effect—that is, of laws of Nature—to be recognized as a premise.

The extension of the like severity of process to political studies is mainly delayed by the constantly disappointing incompleteness of the constituent and preparatory studies just enumerated. A Science of Politics, indeed, has its own special sources of embarrassment, owing, among other things, to the necessity of co-ordinating in one view all the conclusions deducible from those other, and as it were introductory, researches. Of course, this process of combination abounds with its own manifold opportunities of error; but this fact need no more produce despair than the composite quality of physiology leads the student to be skeptical of the scientific character of inquiries into the constitution of the animal world.

There is a vast difference between calling a branch of knowledge a science, because it can only be profitably studied by the use of the same logical methods as are indispensable in the mastery of the best-established physical sciences, and being, as yet, scientifically cultivated, or advanced in outward form to the full proportions of a maturely developed science. It may be, indeed, that, from a number of causes to be shortly adverted to, Politics will always present an appearance neither homogeneous nor, in one sense, exact. But these defects neither impair the genuine truth of the universal laws to which the topic is submitted, nor ought to convey any imputation on the only methods serviceable in treating it.

Admitting, as a provisional and practical postulate, the freedom of the human will, it might indeed seem to be impossible, on the face of it, to bring within the domain of stringent scientific methods any class of materials largely conversant with the direct actions and emotions of mankind. But there are certain corrections which reduce the significance of any skeptical conclusions which might be drawn.

In the first place, the more extensively and minutely historical studies are carried on and the investigations of travelers pursued and recorded, the more uniform does human nature appear, and the more calculable are the actions, sentiments, and emotions of large classes of mankind, when the antecedents and surrounding conditions are ascertained. So far as political inquiries are concerned, it is more with classes, groups, and assemblages of men, and with considerable stretches of time, than with any individual men at a given moment that the investigator is occupied. Thus the historical method, in proportion as it is extensively pursued, contains in itself its own correctives.

But, in the second place, if the researches of historians and the reports of travelers contain an endless and boundless mass of facts which seem rather to increase the list of human eccentricities than to reduce it by discovering a dominant order and an integral unit of progress and purpose, yet here again the problem of finding a scientific form for the theory of government is on the whole simplified rather than otherwise. As explorations of all sorts are multiplied and extend, they take the place of the logical instrument of experiment; and the result of them is, that a limited number of propositions are evolved which admit of being announced with a fair assurance of their universality. If the area of observation be limited, the truths reached will, indeed, be proportionately restricted in number, but within this area they will be none the less valid.

Thus, in the science of political economy, it is not universally true that, in all conditions of society, population tends to increase out of proportion to the means of subsistence ; for the effective desire of individual self-enrichment constitutes in certain conditions a reparative and compensating force. So in law, it is not everywhere true that a human being is, in a legal sense, a person and not a thing ; or that laws proceed from a consciously acting political authority ; or that it is recognized as an axiom that taxation and representation go together. The several propositions here chosen, by way of illustration, from two of the component sciences which, with others, go to constitute the complete range of political studies, and help to convert those studies into a separate science, are only partially and relatively true at certain places and periods. But, within these limits of time and place, their truth, and the truth of all like propositions, is invariable and incontestable.

Thus, if the composite nature of Politics impairs the universality of the majority of the propositions with which it is concerned, this only establishes the relativity of these studies, and in no wise detracts from their usefulness or supersedes the employment of those rigorous logical methods which in other respects continue to be applicable.

2. Another reason which accounts for the unscientific aspect under which political studies usually present themselves is that it very rarely happens, or has happened, that conscious attention to the true character of governmental problems, to their difficulties, and to the modes of their solution, is aroused in any nation till long after a practical solution of some kind has been instinctively resorted to, and a considerable advance in the art of administration achieved.

An exception might be supposed to exist in the case of colonies and dependencies, at the first foundation of which all the materials seem to be within the conscious control of the parent or governing State. But it is just on this very account that theoretical truths have here their most hopeful platform, and are habitually applied in practice to an extent which, because of unnoticed but vitiating errors of calculation, is often fraught with serious hazard. The Cornwallis settlement in Bengal, the early land policy of the Australian colonies, and the attempted central taxation of the American colonies by the British Parliament, are all instances of the over-hasty application, to materials believed to be malleable, of firmly fixed political principles. The principles themselves, indeed, in all these cases, needed re-examination and restatement.

The obstacles to at once applying even the best-established principles of government, in all conceivable emergencies, so soon as conscious attention happens to be awakened to the national needs, are sufficiently obvious. It is not only that the principles themselves usually demand modification in view of the circumstances of the people and of the day, but that the greatest allowance must always be made in all political reforms for the influence of fixed sentiments and habits. It also may happen that bad institutions—such as a bad poor-law system, or, in the criminal law, a falsely-conceived relationship between crimes and punishments—may have generated a vast and complex web of affiliated ideas, customs, institutions, and laws, which can severally be neither defended in principle nor yet rudely disdained and cast aside.

For not only do custom and habit enable a people, or classes of a people, to work in long-established grooves with the smallest amount of friction and obstruction, but the mere fact of the long existence of a familiar usage so far fashions in its own image the mind and even the conscience of a people that a critical reformer has a hard and unpopular task to perform in assaulting even the most indefensible abuses. The large mass of the people, if disused to political change of any but the most cautious, slow, and tentative kind, have their sentiments of loyalty and reverence outraged by the sudden introduction of what is new and unfamiliar. Their mind has been trained and pruned in such a way as to be unable to conceive, as a mere intellectual notion, a better ordered world than that in which they live. Where too great a disparity, both in sentiments and in intellect, exists between the reformer and the people, or even between different classes of the people in the same community, it may show that the times are not yet ripe for changes recommended by deference to the claims of logic and of justice.

Instances in point are supplied by the difficulties experienced by the British Indian Government in dealing with such patently immoral institutions as polygamy ; by the attachment of the Scotch to a law of marriage which notoriously facilitates the most cruel of frauds ; and by the obstacles in all countries to any comprehensive reconstruction of the systems of land-tenure and inheritance, and of civil, and still more of criminal, procedure. These last-mentioned institutions have seldom been radically altered in any country by any process short of revolution, however persuasive the voice of right, of reason, and of utility, in favor of change. So vast is the number of individual persons interested in these classes of matters, so well habituated are they, and consequently so deeply attached, to the recognized forms, usages, or even gestures, customarily in use—many of which are of a public nature and are daily witnessed by all men—that any vital reconstruction seems little short of sacrilege, and the most conclusive reasons in favor of it are scarcely comprehensible.

3. It is needless to point out that the conception of Politics as a Science is much affected by the imperfections of Politics as a practical Art. It is not only by reason of the existence of ineradicable institutions and ideas that the scientific development of political studies is

hampered and delayed. There is another reason of a still more commanding importance which operates in the same direction with a still more signal force. It is that, at any given moment, when the legislator, or administrator, would otherwise most desire to govern with due regard to well-established principles dictated by abstract political science, he is imperatively urged on to the front, and impelled into action, by the pressing necessity of instantly choosing between a limited number of possible alternative courses. Most of all is this the case in what are sometimes called constitutionally-governed countries—that is, countries in which representative institutions have reached a tolerable degree of advancement, and political knowledge and interest are widely diffused. In these circumstances a spontaneous organization of political leaders and their respective followers into parties for the purpose of uniform and combined action is sure to have taken place.

The result is, that an artificial effort will be made, at each critical occurrence which seems to call for the intervention of the Government, to narrow the possible courses of action to a very few immediately intelligible expedients, recommended rather by their rough conformity to some pre-existing schemes or ideals in favor with the different contending parties than by their intrinsic harmony with scientific requirements. No doubt the party leader who is himself imbued with a scientific spirit, and is personally disposed to do as little violence as possible to his cultured instincts, will do his utmost to bring all his measures into the shape which his logical and historical training, applied to all the circumstances of the special case, leads him to desire. But action at once and without further delay is unavoidable. A decision can only be deferred at the cost either of letting go the opportunity for providing a remedy of some sort for a possibly crying abuse; or of openly confessing impotency; or of surrendering to others a leadership which, with all its demerits, is probably believed to be, on the whole, fraught with good rather than with evil. Thus the peremptoriness of political opportunities and the necessity of instant action withstand, in a country with free representative institutions, every effort to impart to political action through a long period a comprehensive, consistent, and scientific character.

It is no wonder if the same class of facts reacts on the intellectual conception of the position of Politics as a subject of study and of knowledge.

The topic is naturally relegated to the region of caprice and accident, or to that of tentative experiment and spasmodic contrivance. This intellectual consequence is intensified by the fact that all Governments—and not least those known at the present day as the freest and, on the whole, the soundest—are habitually made the arena of purely ambitious contention, of selfish aspiration, and even of corrupt conspiracies against the public well-being. The wider the territorial area of any particular Government, and the more complicated and extensive its essential mechanism, the more opportunity there is for the exhibition of personal or, at the most, of local self-seeking. So far as this prevails, Politics becomes degraded into a mere vulgar struggle for money, office, or power. All actual reference to scientific considerations is excluded. The tone of public thought and sentiment becomes proportionately infected, and all the claims which might otherwise be asserted on behalf of Politics to take its place by the side of other sciences dealing with such moral elements as the human Will meet with a skeptical repudiation.

Where free representative institutions are not found, and absolutism of one type or another prevails, the way is more open for a deliberate choice of the policy to be pursued in any sudden emergency. Such a case has presented itself, again and again, on the occurrence of famines in British India. Could such a casualty occur without being long foreseen in a country enjoying a popular constitution, the question of remedies would be instantly debated in every kind of public assembly, and by all the organs of public opinion, with a ferment of party zeal which would daily gain in heat and vehemence, and would impel statesmen to select with over-much precipitation between the limited number of remedial measures which enjoyed, for one cause or another, the popular favor.

The legislation demanded in the case of a failure of the potato-crop in Ireland has more than once illustrated this position. One party advocates the institution of public works, of a purely wasteful or superfluous kind, on an enormous scale ; another is in favor of indiscriminate out-door relief ; a third recommends, with the late Lord George Bentinck, the construction at the public cost of railways, with the purpose at once of employing labor on a large scale and of distributing food. However much a judicious statesman may be opposed to all these views, yet for fear of being reduced to nullity, and of having to give place to opponents, he can only connect his own name with, and invite the adhesion of his followers to, what seems on the whole the least objectionable of the popular alternatives. The utmost he can do is to combine different courses in such a way as that some special evil of one may neutralize some greater evil of another, and to introduce modifications which may escape general attention, but which none the less go some way, at least, to qualify the mischievous operation of the scheme, a professed adoption of which can not be evaded.

It will depend, of course, very largely on the constitutional circumstances of the country how far, even in the case of a pressing emergency, the art of Politics may be made to comply with the requirements of scientifically ascertained laws. Where a large and promiscuous population has to be satisfied or must be appealed to by statesmen for political support, the measures must be instantly intelligible and not too far removed in their conception from the average ken of mankind as represented then and there. The ulterior objects proposed must not belong to a too distant future: the pursuit of them must not involve what seem to most people excessive or disproportionate sacrifices: they must easily and obviously connect themselves with the common wants and feelings of the many at the moment, rather than with the (seemingly) problematical aspirations of a few in the indefinite future.

The case is different where popular government has not yet established itself, and where, in consequence, none of the above obstacles, even at a critical juncture calling for the immediate intervention of the legislator or administrator, are presented. But the exemption of the statesman or ruler from the checks of popular control of a constitutional kind by no means insures a deference to purely scientific demands. Timidity, rashness, prejudice, personal rivalries, and the still less worthy influences of calculating self-interest or of a narrow ambition, dwarf and vitiate a policy not less surely than do the impediments due to popular ignorance and incompetence. The statesman, in the one case as in the other, is bound to act—and this too without delay; and, though a scientific resolution can not be excluded, yet, from one cause or another, the temptations to deviate to this or that side are numerous and urgent. There have indeed been statesmen who have so far impressed their own personality on their policy, and communicated their views and aspirations to the bulk of the governing population that, at special exigencies, the public confidence previously won has enabled them to dictate a course scarcely comprehended by the people at large. Such a position was occupied on certain occasions by Count Cavour in Italy, Presidents Lincoln and Grant in the United States, even to some extent by Prince Bismarck in Germany, to a still greater extent by M. Thiers in France, conspicuously by the Duke of Marlborough for a time in England, and in modern times by Sir R. Peel, Lord Palmerston, and Mr. Gladstone.

So also in Governments not controlled by representative institutions—such as those of almost all the States of Europe except England, up to very recent days—there have always been found exceptional rulers who, in spite of all temptations to indulge selfish prepossessions in favor of ease or aggrandizement, have availed themselves of the peculiar felicity of their situation to pursue a consistent and far-sighted policy, undisturbed by all casual occurrences or misadventures. To this class have belonged many well-known administrators of British India and of the Crown Colonies of Great Britain, as well as certain absolute sovereigns in ancient and modern times.

It appears, then, that not only does the imminent necessity for immediate action present serious obstacles to the pursuit of a policy founded on the teachings of critical observation and a wide-reaching experience—that is, on science—but the mere fact that statesmen are constantly impelled to act at once in directions which very imperfectly correspond to their own conceptions of what is really best throws a shadow of doubt and uncertainty over the scientific character of the studies concerned. It is felt, not unreasonably, that if those who are most concerned to be acquainted with the best methods of political research forbear to turn these methods to account at the moment of the utmost need, this is at least as likely to result from the inherently imperfect and illogical nature of the branch of knowledge in question as from any other cause. To this comprehensive skepticism some of the classes of facts above adverted to may be held to supply an answer. The unscientific character of a policy adopted at any crisis has often been an exact measure of the amount of external pressure applied through the competition of factions, or through the impetuosity of a populace only jaded into an unwonted attention to political affairs by exceptional events. Where this pressure is not at hand, rulers still may, indeed, through unworthy influences and motives, prefer the worse to the better way; but enough instances of the persistent maintenance of a deliberately adopted policy in the face of the most seductive allurements to fluctuation have been exhibited to show that it can not be fairly alleged that Politics must necessarily be unscientific because few in the real business of life have time, or liberty, or tenacity of purpose, sufficient to withstand the impetuous torrent of popular zeal generated by sudden crises or catastrophes.

Probably the most real and enduring objection to the claims of Politics to assume the rank of a true science is the confessedly immature and imperfectly developed character of the component or preparatory studies, apart from which, in their combination with each other, the study of Politics can not be pursued. It has already been noticed that the complex and composite nature of political studies is of itself a presumption against the facility, if not against the possibility, of ever imparting to those studies the rigorous certainty essential to Science. But this presumption is greatly increased by the fact that in such broad but indispensable preparatory studies—confessedly of a scientific aspect—as Ethics, Economics, and Jurisprudence, there are to be found only the very smallest number of uncontroverted propositions. And, even as to the logical methods applicable in each branch of knowledge, no generally assented-to decisions have yet been accepted.

There is thus afforded to the skeptically-minded a wide opening for treating as unscientific a study which, like that of Politics, must be built up on conclusions yet to be established in those other regions of knowledge, but none of which are as yet established with a certainty which is beyond debate. Nevertheless, if it be admitted that those component studies are capable of being placed on a strictly scientific foundation, and only wait for longer time and attention to assume scientific exactness, at least as much may be claimed for Politics, and the composite study may advance in logical perfection at an equal rate with the elementary studies.

The general result of these considerations is that there are a variety of solid reasons which account not only for the reputation acquired by Politics of being an inherently unscientific study, but also for the study itself having advanced only a very short way toward scientific completeness. But most or all of these reasons have been seen to be of a kind which hold out a good promise for the future, and thereby afford an ample encouragement to the use of a strictly logical method in political investigations, and to the attempt to create a scientific structure of ever-increasing completeness in this region, as well as in others more familiarly associated with the name of Science.

A science need not be built on universal, nor even upon general, propositions; and partial, particular, or even probable premises may justify conclusions, drawn with logical correctness, which may be a firm basis for action. Where truths are by their nature restricted in time and place, or where evidence is yet lacking to demonstrate their actual generality, the assemblage of such truths will carry with it a fragmentary and hypothetical character which may to some seem incompatible with the rigid demands of Science. But where the investigator himself proceeds in strict accordance with the severest logical requirements, conducting his ratiocination with the utmost precision, and distinguishing at all points the possible or probable from the certain, the universal or general from the particular, and proof from plausibility or mere conjecture, it matters little what name is given to the branch of inquiry concerned. It lacks no one of the essential elements and recommendations of the best and earliest-established of the physical sciences. Its terms are submitted to the same process of definition, its subject-matter to a like arrangement into groups and classes, genera and species, and the resulting propositions are reached by a course of reasoning as logically irrefutable.

There are, indeed, certain plain indications that the study of Politics is already, even by practical statesmen, being placed on a platform of far higher scientific exactness than ever before.

One of these indications is the large and discriminating use made of statistics. The collection and due use of statistics belong to very modern times; and owing to popular prejudices and social obstacles—such, for instance, as still exist in England with regard to the collection of agricultural and religious statistics—they have not yet received anything like the extension of which they are capable. Nevertheless, it has become the fashion for all the more advanced Governments to rival each other in the breadth, fullness, arrangement, and clearness of the numerical information they obtain on all the groups of national facts which are susceptible of being tabulated in a systematic shape.

These tables of statistics are periodically furnished by the Government, not only for purposes of contemplated legislation, but independently of all thought of immediate use. The fallacious use to which purely numerical facts can be put, with only too seductive a show of plausibility, is beginning to be fully acknowledged and guarded against. But the assurance that the registered number of births, deaths, and marriages, within a given period and area, as well as the periodical records of crime and disease, and, even more obviously, the tabulated increase or decrease of commerce, shipping, and manufactures of different sorts, may serve to point to the presence of general laws—that is, of permanent sequences of cause and effect—is a sufficient justification of the labor and expense involved in obtaining the severally-relevant statistics. The comparison between the numerical results obtained at one time and place and another, and between those presented in different countries, is becoming a political method increasing in prevalence and repute. In many quarters, indeed, the value of purely numerical estimates has been much exaggerated, and its peculiar liability to error, when made a basis of political reasoning, has been too much ignored. But when its limits of application are duly recognized, and care is taken to distinguish legal and political causes from those which are purely ethical or sociological, the study and use of statistics must be regarded as a most valuable ally, and an unmistakable proof of the scientific character of political studies.

Akin to the token which the enlarged use of statistics affords of the growing recognition of Politics as a true science, is the ever-increasing disposition, at the present day, to await, at any political crisis, whether legislative or administrative, the result of a patient examination of evidence as to the state of the facts and the previous history of the question.

It is now the practice in the more advanced countries to take, in the path of serious political change, no step which seems to be other than the next step onward in a course which has become habitual, without first nominating, by one process or another, competent persons to conduct a critical examination and to deliberate and report upon the matter. The most searching powers are often intrusted to this body of persons to enable them to inform themselves not only as to all the interests, in their several proportions, to be affected by the new policy, but as to the history of the general policy pursued in the past, and occasionally even as to the practice in other countries.

It often, indeed, happens that after a laborious investigation, lasting for months or even for years, the popular interest in the once-advocated policy is found to be exhausted, or diverted into new directions, and the thought of new legislation is abandoned, and a voluminous, costly, and invaluable report cast on one side. Such are among the inevitable accidents which retard the progress of Government.

But what is of importance to notice in this place is that the growing disposition to consult past and surrounding facts before inaugurating change belongs to the strictly scientific habit of mind; and if it is true that much laborious investigation seems for the time to be thrown away, yet it seldom happens that complicated and far-reaching changes are encountered without the assistance of a previous impartial and deliberate inquiry of the kind here adverted to. The scientific method, in Politics as elsewhere, is slowly and surely getting the better of the empiric.

THE ECONOMIC FUNCTION OF VICE.

By JOHN McELROY.

FOR some inscrutable reason, which she has as yet given no hint of revealing, Nature is wondrously wasteful in the matter of generation. She creates a thousand where she intends to make use of one. Impelled by maternal instinct, the female cod casts millions of eggs upon the waters, expecting them to return after many days as troops of interesting offspring. Instead, half the embryotic *gadi* are almost immediately devoured by spawn-eaters, hundreds of thousands perish in incubation, hundreds of thousands more succumb to the perils attending ichthyic infancy, leaving but a few score to attain to adult usefulness, and pass an honored old age, with the fragrance of a well-spent life, in a country grocery.

The oak showers down ten thousand acorns, each capable of producing a tree. Three fourths of them are straightway diverted from their arboreal intent, through conversion into food by the provident squirrel and the improvident hog. Great numbers rot uselessly upon the ground, and the few hundreds that finally succeed in germinating grow up in a dense thicket, where at last the strongest smothers out all the rest, like an oaken Othello in a harem of quercine Desdemonas.

This is the law of all life, animal as well as vegetable. From the humble hyssop on the wall to the towering cedar of Lebanon—from the meek and lowly amœba, which has no more character or individuality than any other pin-point of jelly—to the lordly tyrant, man, the rule is inevitable and invariable. Life is sown broadcast, only to be followed almost immediately by a destruction nearly as sweeping. Nature creates by the million, apparently that she may destroy by the myriad. She gives life one instant, only that she may snatch it away the next. The main difference is that, the higher we ascend, the less lavish the creation, and the less sweeping the destruction. Thus, while probably but one fish in a thousand reaches maturity, of every 1,000 children born 604 attain adult age. That is, Nature flings aside 999 out of every 1,000 fishes as useless for her purposes, and two out of every five human beings.

Many see in this relentless weeding out and destruction of her inferior products a remarkable illustration of the wisdom of Nature's methods. What would they think of a workman so bungling that two fifths of the products of his handicraft were only fit for destruction?

The "struggle for existence" is a murderous scramble to get rid of this vast surplusage. The "survival of the fittest" is the success of the minority in demonstrating that the majority are superfluous. It is the Kilkenny-cat episode multiplied by infinity. It will be remembered that the whole trouble arose from their common belief that two cats were a surplus of one for the Kilkenny environment.

Darwin's theory recognizes in this super-fecundity of Nature her most potent agency for improvement. He says, in effect, that the impossibility of providing subsistence for more than a fraction of the multitudinous creation causes a mortal struggle, in which the weaker and inferior are exterminated, and only the stronger and superior survive. These in turn have offspring like the leaves of the forest, which in like turn are winnowed out by alien enemies, and ruthless reciprocal extermination, the process going on continually with the sanguinary regularity of the King of Dahomey's administration of the internal economy of his realm. The benignity of this method of arranging the order of Nature is not so apparent as a member of the Society for the Prevention of Cruelty to Animals might desire.

But our opinion of this law is not cared for. The main importance attaches to the recognition of the fact that it *is* a law. Its application to society is obvious: Since the propagation of human beings goes on with entire recklessness as to the quality of the product and the means of subsistence, some strong corrective is absolutely necessary to establish limits to population, and to secure the continued development of the race. If every begotten child lived to the average age of forty, in a very few years there would not be standing-room on the earth for its people! Even with such limited propagators as the elephant, each female of which produces but six offspring in her bearing period of ninety years, we are told that, if the species had no parasitic or other enemies, it would only be 740 years until elephants overran the earth. Where, then, should we assign limits to the productiveness of the 700,000,000 human females on the globe, each of whom is capable of producing twenty children in her thirty years of bearing? If, too, every child had the same chance of life, without reference to its mental and physical fitness to live, humanity would soon become a stagnant slough of vicious vitality. As there are only food and room for the best, and as the development of the race demands it, only the best survive, and continue the work of propagation. The rest are destroyed. By "the best" is understood those having that harmony of mental and physical development which brings them most nearly into accord with natural laws.

Below the human strata, superabundant generation is neutralized by the simple device of having every organism prey upon some other one. In her ten years of fruitful life the female cod lays 50,000,000 eggs. If nothing thwarted the amiable efforts of herself and offspring to multiply and replenish, they would shortly pack the ocean as full as a box of sardines. But, while giving one animal the desire and capacity to produce 50,000,000 lives, Nature has given other animals the desire and capacity to annihilate those 50,000,000 lives. So, all through the animal kingdom it is nearly a neck-and-neck race between Production and Extermination.

Man alone is practically exempt from what is apparently an inseparable condition of all other forms of animal life. While he preys on a myriad of created things, there is no created thing that preys on him, and assists in keeping his excessive reproductiveness within the limits of subsistence. Most singular of all, not even a parasite wages destructive warfare against him.

This absence of destructive enemies must be compensated for in some way, and it is accomplished by making vicious inclinations the agents to weed out the redundant growths, and to select for extermination those which are inferior, depraved, weak, and unfit for preservation or reproduction.

If five human beings are procreated where there is present room and provision for but three, how are the surplus two to be picked out and exterminated? Of course, each one of us feels entirely competent to pick out in his own community the persons who could be best spared, but public opinion is at present hostile both to any practicable plan of making the necessary thinning out, and also to lodging the power of selection in the hands of even those of us best qualified for the duty.

Fortunately, the surplus ones relieve us from embarrassment on this score, by selecting and exterminating themselves. Their methods of suicide cover a wide range of expedients, but all are very effectual. Most beneficent of any of the facts that we have to consider is the one that each of those chosen for extermination embraces his fate with eagerness, under the delusion that he is about to enhance his own happiness. Immoderate use of stimulants, and the various excesses and vital errors which are grouped under the general head of "dissipation," a "life of pleasure," or the still more expressive phrase, "a short life and a merry one," etc., are favorite plans of self-annihilation, and leave little to be desired in the completeness with which they do their work.

Competent English statisticians estimate that, after a man has begun drinking beer in large quantities, it takes him 21·7 years to kill himself, and a whiskey-drinker shortens the time to 16·1 years. Intemperance, being among the milder vices, kills slowly. Sexual sins slay more rapidly, and the higher grades of vice do their work with a swiftness proportioned to their flagrancy. The Psalmist says, "Bloody and deceitful men shall not live out half their days," but police records will show that David materially overstates the average. "One quarter their days" would approach much nearer exactness.

Returning to the major premise, that the "survival of the fittest" means the selection and preservation of those individuals who are most nearly in harmony with the conditions of their environment, and that the progress of the race or species involves the destruction of the weaker and inferior, who are not in such harmony, the conclusion follows that any aberration toward vice shows such a discordance in the individual with the laws of his environment as marks him as inferior, weak, and obstructive of the race's development.

Vice is not so much a cause as an effect—not so much a disease as a symptom. Vice does not make a nature weak or defective: a weak and defective nature expresses its weaknesses and defects in vice, and that expression brings about, in one way or another, the sovereign remedy of extermination. ·

Temperance agitators fill our ears continually with wails as to how the "demon Alcohol is yearly dragging down to dishonorable graves hundreds of thousands of the brightest and fairest of our land." This is supreme nonsense. With very few exceptions, every one who goes to perdition by the Alcohol route would reach that destination by some other highway, if the Alcohol line were not running.

Every man whose sloth or improvidence has brought himself and his family to beggary, every thieving tramp upon the highways, every rascal in the penitentiary, every murderer upon the gallows, hastens to plead, "Whisky brought me to this!" because he knows that such a plea will bring him a gush of sloppy sympathy not obtainable by any other means. But whisky makes no man lazy, shiftless, dishonest, false, cowardly, or brutal. These must be original qualities with him. If he has them, he will probably take to whisky—though not inevitably—which then does the community the splendid service of hurrying him along to destruction, and of abridging their infliction upon the public. People who have done much in the way of reforming drunkards have been astonished to find how little real manhood remained after eliminating whisky from the equation. They have supposed the manhood to be only obscured, and have been disheartened to find how frequently it happens to be demonstrated that there was never enough of it to pay for the trouble of "saving the victim of intemperance."

If, as the temperance agitators insist, "intemperance is yearly dragging a hundred thousand of the men and women of our country down to the grave," then a love of scientific truth compels the statement that intemperance, while doing some harm, as is usually the case with natural agents, is also doing an immense amount of good. By far the greater portion of those who thus succumb to alcoholization, and to the deadly practices that usually accompany it, are thieves, thugs, prostitutes, gamblers, sharpers, ruffians, and other members of the criminal and *quasi*-criminal classes, upon whom whisky accommodatingly performs the office of judge and executioner, cutting their careers off at an average of five years, where, without this interposition, they would be extended to possibly twenty or thirty. The certainty and celerity with which it ferrets out and destroys these classes recommends it strongly over the ordinary processes of justice.

It was exceedingly unfortunate for the community that all the leaders in the James gang were strictly temperate men. Had it not been so, their career, instead of extending over twenty terrible years, would have been cut short inside of five. Uncontrollable predilections for whisky and the society of strange women brought about the destruction of nearly all of the band, who from time to time were slain by each other's hands or those of justice. Temperance and chastity in a rascal of any kind mean an immense amount of mischief to the community. Fortunately, they are quite rare.

During the ages of terrible oppression of the European people, which culminated in the French Revolution, the main amelioration of the hardships endured was found in the vices of the oppressors. The sword of the duelist, the picturesque horrors of *delirium tremens*, and the loathsome *mal de Naples*, continually swept away hecatombs of tyrant lordlings, and frequently obliterated whole families. In fact, no aristocratic family ever withstood these adverse influences very long. Extinction came as promptly and as certainly as the curculio to the ripening plum.

The student of French and English history is continually astonished at the brief time in which noble names remain in view. They rise to dazzling eminence on one page, and on the next go down to oblivion. One rarely finds a name of a century or two ago mentioned in any of the European news of to-day. Mr. Freeman, the eminent English historian, shows conclusively that, in spite of the perennial vaunt of ancestors who "came over with the Conqueror," and of Tennyson's musical mendacity about the "daughter of a hundred earls," the families who can trace back to even so recent a date as the reign of the Stuarts are quite rare. Idleness, luxury, and more or less flagrant debauchery have done their appointed work in removing the deteriorated forms of human life from the world, that their room might be had for more acceptable growths.

Society has been most aptly likened to a vat of good wine, which is all scum and froth at the top, dregs and sediment at the bottom, and good, pure, clear liquor in the middle. Vice does admirable work in skimming away the supernatant scum, and in drawing off the dregs and settlings. Unceasing fermentation seems to be a condition necessary to the health of society. The humblest work incessantly to lift themselves into the ranks of the middle classes. The middle classes strive as earnestly to make themselves plutocrats, aristocrats, and lordlings. This passion for worldly advancement is one of society's most powerful engines for good. When a man at last reaches the social summit, he desists from further efforts at improvement, or, if this period comes too late in life, his children do it after him. He becomes like a man who has struggled forward to the head of a procession, and then refuses to march another step. Some vice speedily removes him, and clears the ground for another man to come to the front, who is also removed summarily when he becomes obstructive. Were it not for this, the upper stratum of society would speedily become so crowded that ascent to it would be impossible, all healthful, ambitious motive be taken away from the middle and lower classes, stagnation follow, and society perish from congestion.

History is full of illustrations of the benefits of vice in assisting to shape the destinies of nations and peoples. Take, for example, the Bourbons, whose stupidity and tyranny have passed into a proverb. In the last century their worse than worthless carcasses filled nearly every throne in Southern Europe. They seemed to breed like wolves in a famine-stricken land, and their fangs were at every people's throat. Fortunately, they had vices. Wine and lechery did what human enemies could not. The pack of wolves rotted away like a flock of diseased sheep. The mortality was so great that for a long time French kings were succeeded by their grandsons, and great-grandsons, their sons all burning themselves out before the time came for ascending the throne. The unutterably vile life of Louis XV was terminated by the small-pox, communicated to him in the course of a most disgraceful amour. His grandson, who succeeded him, had no destructive vices, and so the people were compelled at last to resort to the guillotine to rid themselves of him. The vast problem before the French in 1790 would have been greatly simplified if Louis XIV had been a short-lived *débauché* like his father and two brothers. The healthy German blood of his Saxon mother corrected somewhat the virus in the Bourbon veins, and he lived to become an intolerable cumberer and obstructive.

The only Bourbon still remaining on a throne is the King of Spain, with whom the race, as a royal family, will probably become extinct. His teeth are on edge from the sour grapes of unchastity which his fathers ate. Like his mother, the notorious Isabella II, his sisters and cousins, and indeed every one of the Bourbons, the scrofula, into which the ancestral syphilitic taint has been modified, has made of him a mass of physical decay. In his mother it has shown itself in a very disgusting cutaneous disease, which she has for years tried to ameliorate or cure, in a truly Bourbonish way, by wearing the underclothing of a nun of high repute for piety. His sisters and kinsmen all have some one or more of the scrofula's varied physical degradations or sickening deformities, and occasionally one of them goes out like an ill-made candle.

A few years ago the people of Holland were threatened with a most serious calamity. Depraved heredity, unwise sexual selection, or some other controlling cause, had resulted in the production, as the Prince of Orange—the crown prince—of an individual of a weak, inferior, and depraved nature. His was such a nature as, on a throne, becomes a fountain of numberless oppressions and evils, and rarely fails to goad the unhappy subjects into rebellion, attended with the usual frightful losses of life and property and vast sorrows. Fortunately, he had destructive vices. The appetites of these led him to Paris. A few years of riot and debauchery sapped away the dangerous life of "Lemons," as his worthless boon companions nicknamed him, and he died as the fool dieth. The only harm he was able to do was the indirect damage of a bad example, and the good people of the Netherlands were rid of a possible Louis XV, at no greater cost than that of some years of extravagant life in the French capital. His father's youthful excesses and present *penchant* for pretty ballet-girls have rendered it wholly improbable that there will be any other heirs to the Dutch throne, and so the country will shortly glide into a republic, without any of the wrench and sanguinary convulsions that usually attend such political transitions. The superior economy and other advantages of a Parisian brothel over civil war as a political means are obvious to the naked eye.

The most commendable feature of this self-pruning of the objectionable growths in society is that the victims destroy themselves under the hallucination that they are drinking the richest wine of earthly pleasure. When execution can be made a matter of keen relish to the condemned, certainly nothing is wanting on the score of humanity.

I anticipate the objection that slaying bad men by means of their own vicious propensities brings much misery to those connected with them. But then all innocent persons connected with bad men are fated to suffer in exact proportion to the closeness of the connection, whether the bad men are destroyed or not. Weak, selfish, perverted, and criminal men always inflict misery upon their relatives and associates. This is not usually intensified by their being also drunkards, or *débauchés*. It is also true that no one of Nature's methods of extinction is pleasant to those connected with the victim. A thief or a thug providentially dying with the *delirium tremens* is certainly quite as bearable a sight to those before whose eyes it may come as the spectacle of a virtuous man, the sole support of his family, slowly wasting away with consumption, in spite of all that loving services and agonizing sympathy can do to retain for him a life that is of so much value to all.

To the next objection, that the practice of vice is not inevitably suicidal, since many rascals live to attain as green an old age as the most righteous, it is sufficient to say that, plentiful as these exceptions may occasionally seem, their proportion to the whole number is at least as small as that of the exceptions to any other general law of biology. The policeman on the next corner will bear decided testimony that the number of scoundrels who survive their thirtieth year is astonishingly small, and he can point out any number of very troublesome members of the community who are ending their lives in penitentiary or poor-house hospitals, at an age when well-behaved men are just entering upon the serious business of life.

It is also demonstrable that the proportion of vicious men to the whole population is much less to-day than at any previous period in the history of the race. This shows conclusively the improvement of society by the self-destructiveness of vice. The proportion of bad men is steadily diminishing, because bad men die sooner, and propagate fewer, than good ones.

PROGRESS OF THE BACKBONED FAMILY.*

By ARABELLA B. BUCKLEY.

THERE is much uncertainty as to how the backboned or vertebrate animals began; but the best clew we have to the mystery is found in a little, half-transparent creature, about two inches long, which is still to be found living upon the English shores and the Southern Atlantic coast of the United States. This small, insignificant animal is called the "Lancelet," because it is shaped something like the head of a lance; and it is in many ways so imperfect that naturalists believe it to be a degraded form, like the acorn-barnacle—that is to say, that it has probably lost some of the parts which its ancestors once possessed. But, in any case, it is the most simple backboned animal we have, and shows us how the first feeble forms may have lived. Truly, it is only by courtesy that we can call him a backboned animal, for all he has is a cord of gristle, pointed at both ends, which stretches all along the middle of his body above his long, narrow stomach; while above this, again, is another cord containing his nerve-telegraph.

There are large fishes, too, which have this cartilaginous backbone. The young shark has nothing but a rod of gristle or cartilage, and, though he is one of the strongest of sea-animals, *he retains this gristly state of his skeleton throughout his life;* however much he may strengthen it by hard matter, it never becomes true bone.

* Abridged from Miss Buckley's book, entitled "Winners in Life's Race; or, The Great Backboned Family," from which also the illustrations are borrowed.

The first feeble ancestors of the shark and the sturgeon appear at a time when the crustaceans were the most powerful animals in the world, and the huge, lobster-like Pterygotus was the monarch of the

Fig. 1.

seas. The plated-scaled fish which existed at the same time were clumsy creatures, for their skeletons were probably feeble, and their armor-like shields were heavy. So, as history went on, they gradually gave way, becoming smaller and rarer, while the more active little shark-like animals gradually grew strong and powerful, and from them are descended the giant sharks of to-day.

The powerful gristly-boned fishes are much excelled in agility by the herring, the salmon, and their other bony companions, which move with much less effort in the water, and so have naturally made their way into all parts of the rivers and seas. But where have they come from? We know very little of their early history, but what little we do know leads us to think that long ago they branched off from the enameled-scaled fish, and struck out a path of their own, to make the most of the watery world.

If we wanted to pick out the strangest and strongest proof of how the shape of fish is altered to suit their wants, we need seek no further than the flat-fish. The young sole, when it comes out of the egg, is not flat like the young skate, but a very thin, spindle-shaped fish, something like a minnow. He is then about the size of a grain of rice, very trans-

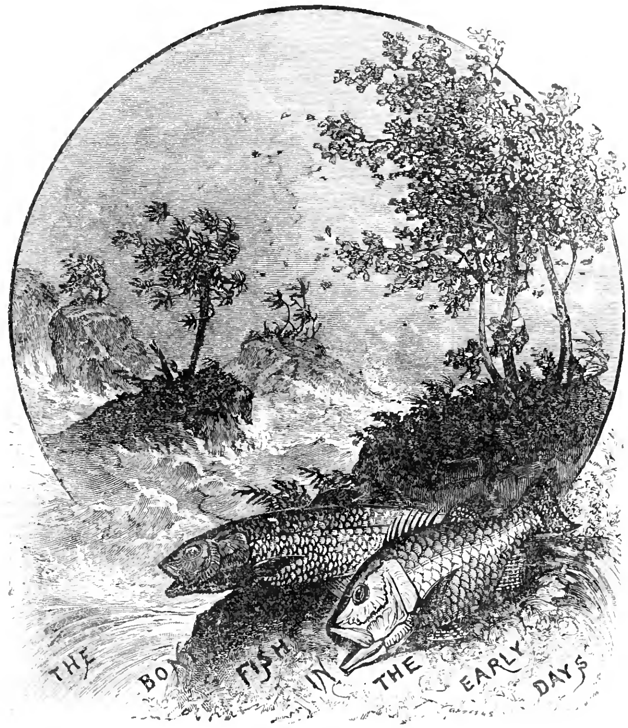

FIG. 2.

parent, and lives at the top of the sea. He has one eye on each side, like other fish, only one eye is higher up than the other, and the single fin on its back and the one under its body reach almost from head to tail. In this way he swims for about a week, but he is so thin and deep, and his fins are so small, that swimming edgewise is an effort, and soon he falls down on one side, generally the left, to the bottom of the sea. Many times he rises again, especially at first, till he has got used to breathing at the muddy bottom, and meanwhile the eye that lies underneath is gradually working its way round to the upper side, his forehead wrinkles so as to draw the under eye up, while his whole head and mouth receive a twist which he never afterward loses. His skeleton, it must be remembered, is still very soft, and the bones of his face are easily bent; and at last this eye is screwed round, and as he lies at the bottom he can look upward with both eyes, and save the under one from getting scratched by the sand, as it must have done if it had remained below.

It is clear that if the backboned animals were ever to live upon land, after they had begun their career in the water, there must have been some among them which learned gradually to give up water-breathing, and to make use of free air; and we shall not have far to seek for creatures which will help us to guess how they managed it.

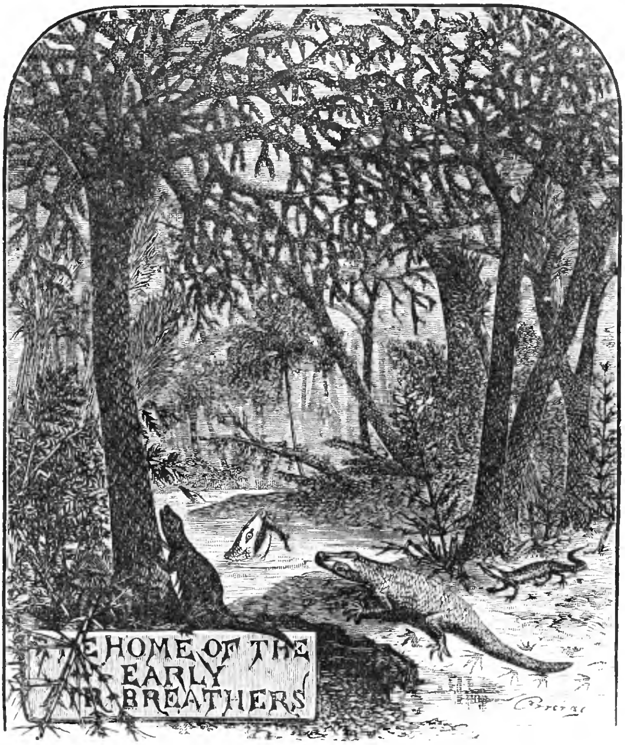

Fig. 3.

The common tadpole is to all intents a fish. He swims with a fish's tail; he gulps in water at his mouth, passing it out at the slits in his throat after it has poured over his fish's gills. Moreover, he has a fish's heart, of two chambers only, which pumps the blood into these gills to be freshened, while, like the lamprey, he has a gristly cord, enlarged at the end to form a gristly skull, a round sucking mouth, and no limbs. As he grows bigger and more active week by week, two little bumps appear, one on each side of his now bulky body, just where it joins the tail. These bumps grow larger every day, until, lo! some morning they have pierced through the skin, and two tiny hind legs are working between the body and the tail. In about another week the front legs appear, and we have a small four-legged animal with a lamprey's tail.

During this time a bag has been forming inside, at the back of the throat, which afterward divides into two, forming a pair of lungs, which he uses when out of the water, though still using his gills when below. Little by little the blood-vessels going to the gills grow smaller, and those going to the lungs grow larger; while the fish's two-chambered heart is dividing into three chambers—one to receive the blood from the body, another to receive it from the lungs, and one to drive this blood back again through the whole animal. Now that he can leap and swim with his legs, his tail is no longer of use to him, and it is gradually sucked in, growing shorter and shorter, till it disappears. Thus our backboned animal has succeeded in getting out of the water on to the land.

FIG. 4.

If we glance back to the far-off time when the ancient fishes were wandering round the shores and in the streams of the coal-forests, we find that the *amphibia* were not then the small, scattered groups they are now, but huge and powerful creatures, which sported in the water or wandered over the land with sprawling limbs, long tails, and bones on which gills grew, while their heads were covered with hard, bony plates, and their teeth were large, with folds of hard enamel on the surface.

And now the transformation is complete, for, when we pass on to the next division of backboned animals, the "reptiles," we hear nothing more of gills, nor air taken from the water, nor fins, nor fishes' tails. We shall all allow that the tortoises are the most singular of any. Slow, ponderous creatures, with hard, bony heads, wide-open, expressionless eyes, horny beaks, and thick, clumsy legs, the tortoises seem, at first sight, to be only half alive, as they lumber along, carrying their heavy shell, and eating, when they do eat, in a dull, listless kind of way. This sluggishness would certainly be their ruin, in a bustling, greedy world, if it were not for the strong box in which they live. You would hardly guess that the shell of the tortoise is part of his skeleton. But it is so. The arched dome which covers his back is made of his backbone and ribs, and the shelly plates arranged over it are his skin hardened into horny shields, which, in the hawk's-bill turtle, form the tortoise-shell which is peeled off for our use; while the flat shell under his body is the hardened skin of his belly, and the bones which belong to it.

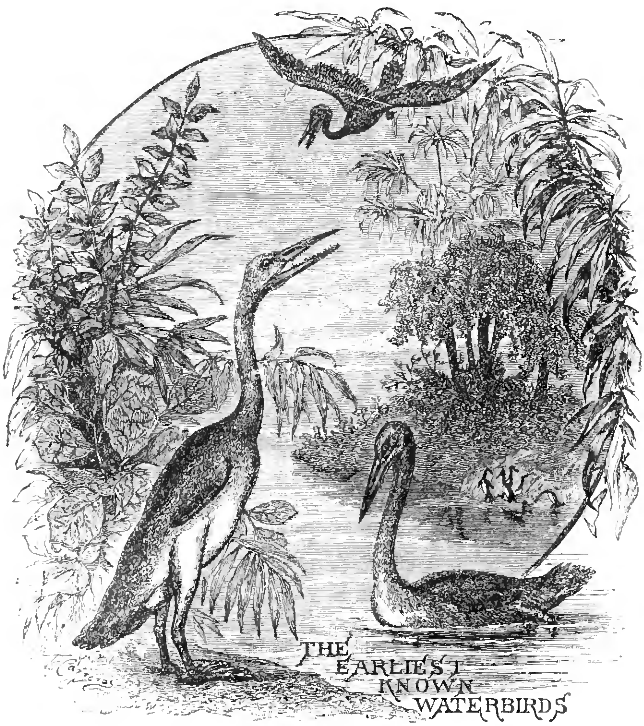

Fig 5.

It is not without some struggle that the cold-blooded reptiles have held their own in the world, nor is it to be wondered at that only four types—tortoises, lizards, crocodiles, and snakes—should have managed to find room to live among the myriads of warm-blooded animals which have filled the earth. These four groups have made a good fight of it, and many of them even make use of warm-blooded animals as food. The tortoises, it is true, feed upon plants, except those that live in fresh water, and feed chiefly on fish, snakes, and frogs, while most of the lizards are insect-feeders. But the crocodile, as he lurks near the river's edge, and the snake, when he fastens his glittering eye on a mouse or bird, are both on the lookout for animals higher in the world than themselves.

We come now into quite a new life, for we are going to wander among the conquerors of the air, who have learned to rise far beyond our solid ground, and to soar, like the lark, into the clouds, or, like the eagle, to sail over the topmost crags of the mountains, there to build his solitary eyrie.

In those far by-gone times, when the huge land-lizards browsed upon the trees, the birds living among them were much more like them in many ways than they are now. Of water-birds there were some about the size of small gulls, which flew with strong wings and had fan-shaped tails, but had teeth in their horny jaws, set in sockets like those of the crocodile, while their backbones had joints like those of fishes rather than birds; and with them were other and wingless birds rather larger than our swans, but more like swimming, fish-eating ostriches.

In these and many other points the early birds came very near to the reptiles—not to the flying ones, but to those which walked on the land. And now, perhaps you will ask, Did reptiles, then, turn into birds? No, since they were both living at the same time, and those reptiles which flew did so like bats, and not in any way like the birds which were their companions. To explain the facts, we must go much further back than this. If any one were to ask us whether the Australian colonists came from the white Americans or the Americans from the Australians, we should answer, "Neither the one nor the other, and yet they are related, for both have sprung from the English race." In the same way, when we see how like the ancient birds and reptiles were to each other, so that it is very difficult to say which were bird-like reptiles and which were reptile-like birds, we can only conclude that they, too, once branched off from some older race which had that bone between the jaws, that single neck-joint, and the other characters which birds and reptiles have in common.

But where have the feathers come from—those wonderful, beautiful appendages without which the bird could not fly? They are growths of his skin, of the same nature as the scales of reptiles, or those on the bird's own feet and legs; and on some low birds, such as the penguins, they are so stiff and scale-like that it is often difficult to say where the scales end and the feathers begin. All feathers, even the most delicate, are made of horny matter, though it splits up into so many shreds as it grows that they look like the finest hair, and Dr. Gadow has reckoned that there must be fifty-four million branches and threads upon one good-sized eagle's feather.

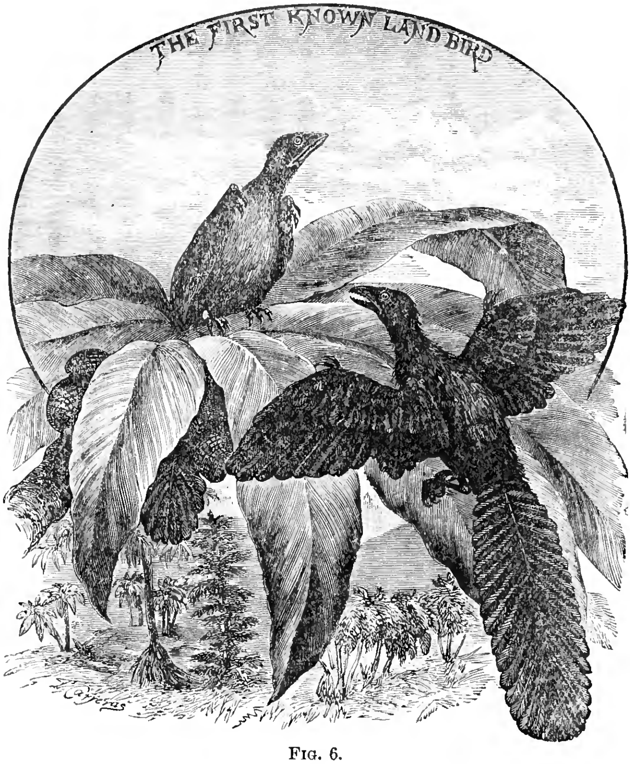

FIG. 6.

From their skeletons and feathers which we find, we know that the strange land-birds which perched on the trees at the time that large reptiles were so numerous had not a fan-shaped tail, made of feathers growing on one broad bone, as our birds have now, but they had *a long tail of many joints like lizards*, only that each joint carried a pair of feathers, and like lizards, too, they had *teeth in their jaws*, which no living bird has. They must have been poor fliers at best, these earliest known birds, for their wings were small and the fingers of their hand were separate more like lizards' toes, two of them at least having claws upon them, while their long, hanging tail must have been very awkward compared to the fan-shaped tail they now wear.

Our backboned animals have now traveled far along the journey of life. The *fish*, in many and varied forms, have taken possession of the seas, lakes, and rivers; the *amphibia* fill the swamps and the debatable ground between earth and water; the *reptiles* swarm in the tropics, and even in colder countries glide rapidly along in the warm sunshine, or hide in nooks and crannies, and sleep the winter away; and the *birds*—the merry, active, warm-hearted birds—live everywhere.

Yet still the great backboned division is not exhausted; on the contrary, the most powerful if not the most numerous group is still to

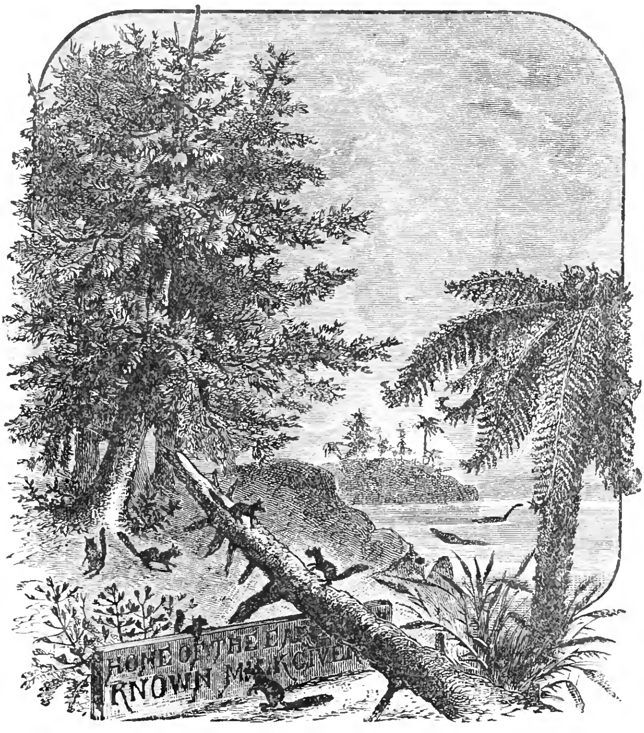

FIG. 7.

come—the *mammalia*, or milk-giving animals. Let us first notice two important changes which give them an advantage over other backboned creatures. We have found the fish casting their eggs out into the water, and, as a rule, taking no more thought of them; so it was again with the frogs, so with the reptiles, whose eggs, even when carefully buried by the mother, are often devoured by thousands before the little ones have a chance of creeping out of the shell. And with the birds, in spite of the parents' care, more eggs probably are eaten by snakes, weasels, field-rats, and other creatures, than remain to be hatched.

Now, the cat and the cow, as we all know, do not lay eggs as birds do; but the mother carries the young within her body till they are born, perfectly formed, into the world. And when at last her little ones see the light, the mother has nourishment ready for them: part of the food which she herself eats is turned into milk, and secreted by special glands, so that the newly-born calf or kitten is suckled at its mother's breast till it has strength to feed itself.

Among the earliest milk-givers must have been the ancestors of the curious pouched creatures of Australia, the "marsupials," which have a large pouch of skin, into which the mothers put their little ones when they are less than two inches long, and so imperfect that their legs are mere knobs, and they can do nothing more than hang on to the nipple with their round, sucking mouths, as if they had grown to it.

There the little ones hang, day and night, and their mother, from time to time, pumps milk into their mouths, while they breathe by a peculiar arrangement of the windpipe, which reaches up to the back

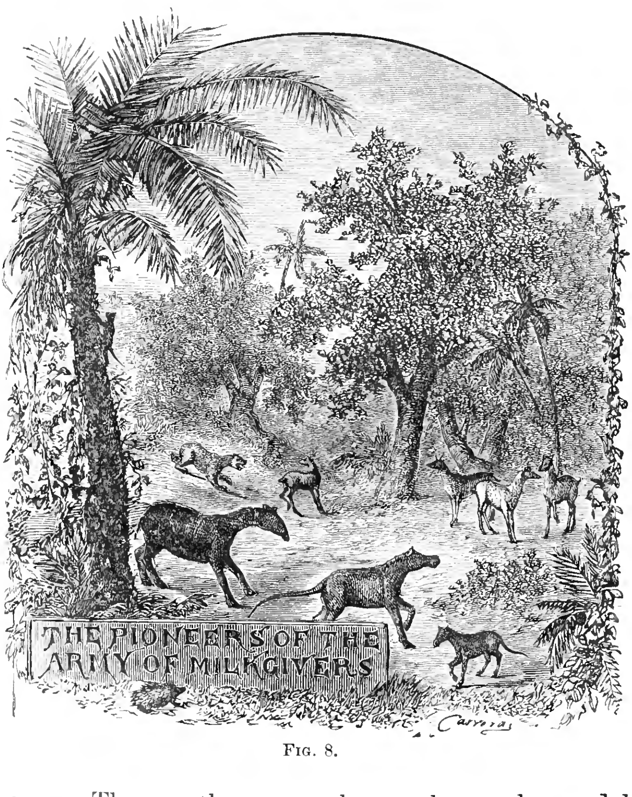

FIG. 8.

of their nose. Then, as they grow, the pouch stretches, and by-and-by they begin to jump out and in, and feed on grass as well as their mother's milk.

Other singularly old-fashioned animals may be found in a Brazilian forest. The furry little opossum, the dreamy sloth, the strange ant-bear, and the armadillo, whose back is covered with long shields like the crocodile.

Having now taken leave of the curious pouch-bearers and the strange primitive sloths and armadillos, we find ourselves left to deal with an immense multitude of modern mammalia, which have spread in endless variety over the earth, and which may be divided into five great groups: the *Insectivora*, or insect-eaters; the *Rodents*, or gnawers; the climbing and fruit-eating lemurs and monkeys; the *Herbivora*, or large vegetable-feeding animals; and the *Carnivora*, or flesh-eaters.

It is clear that the *Rodents* and *Insectivores* do not hold their place in the world by strength or audacity. Both lowly groups, of simple structure and with comparatively feeble brains, they have chiefly escaped destruction from higher forms by means of their nocturnal and burrowing habits or arboreal lives, and the marvelous rapidity with which they breed, combined with their power of sleeping without food during the winter in all cold countries. But the insect-eaters have no water-animal to match the beaver among rodents in sagacity or engineering. With his chisel-like front teeth he gnaws a deep notch in the trunk of a larch or pine or willow, and then, going round to the other side, begins work there till the trunk is severed and falls heavily on the side of the deep notch, and therefore away from himself. He always makes the deep notch in the trunk on the side near the water, so that the tree in falling comes as near as possible to the stream. Then, after stripping off the bark and gnawing the trunk into pieces about six feet long, he uses his fore-paws and his teeth to drag them into position to build his dam. He does not always clear away all the branches, but he and his companions place the logs with these lying *down* the stream, so that they act as supports to resist the current and prevent the dam being washed away. Thus they make a broad foundation, sometimes as much as six feet wide, and upon this they pile logs and stones and mud till they have made a barrier often ten feet high and more than a hundred feet long. The lighter branches he uses to make his oven-shaped lodge, laying them down in basket-work shape, plastering them with mud, grass, and moss, and lining the chambers with wood-fiber and dry grass.

There remain to be noticed two groups of much larger animals: first, the *Herbivora*, or grass-feeders; and, secondly, their great enemies, the *Carnivora*, or flesh-feeders. We shall see that the vegetable-feeders have filled every spot where they could possibly find a footing, and if we could only trace out their pedigree we should be surprised to find how wonderfully each one has become fitted for the special work it has to do. But three things they all require and have. The *first* of these is a long face and freely-moving under jaw, with large grinding teeth to work up and chew the vegetable food; the *second*, a capacious stomach to hold and digest green meat enough to nourish such bulky bodies; and, the *third*, good defensive weapons to protect themselves against each other and against their enemies.

FIG. 9.

In the three-toed group of the vegetable-eaters, the horse has the most interesting history. It was in America that the tribe began, for there we find that tiny pony not bigger than a fox, with four horn-covered toes to his front feet (and traces of a fifth), and three toes on his hind ones. Then, as ages went on, we meet with forms with only three toes on all the feet, and a splint in the place of the fourth on the front ones. In the next period they have traveled into Europe, and we find larger animals with only three toes of about equal size. One more step, and we find the middle toe large and long, and covered with a strong hoof, while the two small ones are lifted off the ground. Lastly, in the next forms, the two side-toes became mere splints; and, soon after, well-built animals with true horse's hoofs abounded, the one large hoof covering the strong and broad middle toe. For what we call a horse's knee is really his wrist, and just below it we can still find under the skin those two small splints running down the bone of the hand, while the long middle finger, or toe, with its three joints, forms what we call the foot. It is by these small splints that the horse still reveals to us that he belongs to the three-toed animals.

A far different race from the *Herbivora* is the large army of flesh-feeders, which we find throughout all past ages harassing and destroying the vegetable-feeders on all sides. And yet it would not be fair to speak of these larger flesh-feeding animals as if they had worked nothing but evil to their more peaceful neighbors, for how would Life educate her children if she put no difficulties in their way to be conquered, no sufferings to be endured? It was in the long struggle for life that the animals with the largest and strongest horns got the upper hand, that the swiftest horses or antelopes survived and left young ones; while we must remember that it is more often the sickly, worn-out, and diseased animals that fall a prey to the devourers, and their life is ended far less painfully than if they dragged themselves into some hole to die.

"*On revient toujours à ses premiers amours,*" says the French song. But who would have thought that, after rising step by step above the fish, and tracing the history of the backboned animals through their development in the air and over the land till we brought them to a state of intelligence second only to man, we should have to follow them back again to the water and find the highly-gifted milk-givers taking on the form and appearance of fishes? Nevertheless it is so, for seals and whales are as truly flesh-eating milk-givers as bears and wolves. "Do you really mean, then," exclaim nearly all people who are not naturalists, "that a whale is not a huge fish?" Certainly I do! A whale is no more a fish than crocodiles, penguins, or seals, are fishes, although they too live chiefly in the water.

A whale is a warm-blooded, air-breathing, milk-giving animal. Its fins are hands with finger-bones, having a large number of joints; its tail is a piece of cartilage, and not a fish's fin with bones and rays; it has teeth in its gums, even if it never cuts them; and it gives suck to its little one just as much as a cow does to her calf. Nay, the whale-bone whales have even the traces of hind legs entirely buried under the skin, and in the Greenland whale the hip-joint and knee-joint can be distinguished with some of their muscles, though the bones are quite hidden and useless.

There was once a time when the great army of milk-givers had its difficulties and failures as well as all the other groups, only these came upon them not from other animals, but from the influence of snow and ice.

For we know that, from the time of tropical Europe, a change was creeping, during long ages, over the whole northern hemisphere. The climate grew colder and colder, the tropical plants and animals were driven back or died away, glaciers grew larger, and snow deeper and more lasting, till large sheets of ice covered Northern Europe, and in America the whole of the country as far south as New York.

True, there were probably warmer intervals in this intense cold, when the more southern animals came and went, for we find bones of the hippopotamus, hyena, and others buried between the glacial beds

FIG. 10.

in the south of England. But there is no doubt that at this time numbers of land-animals must have perished, for in England alone, out of fifty-three known species which lived in warmer times, only twelve survived the great cold, while others were driven southward, never to return.

Moreover, when the cold passed away, and the country began again to be covered with oak and pine forests where animals might feed and flourish, we find that a new enemy had made his appearance. Man—active, thinking, tool-making man—had begun to take possession of the caves, making weapons out of large flints bound into handles of wood, and lighting fires by rubbing wood together, so as to protect himself from wild beasts and inclement weather.

Many and fierce must have been his conflicts, for the wild beasts were still strong and numerous, and man had not yet the skill and weapons which he has since acquired. But, rough and savage though he may have been, he had powers which made him superior to all around him. He had a brain which could devise and invent, a memory which enabled him to accumulate experience, and a strong power of sympathy which made him a highly social being, combining with others in the struggle for life.

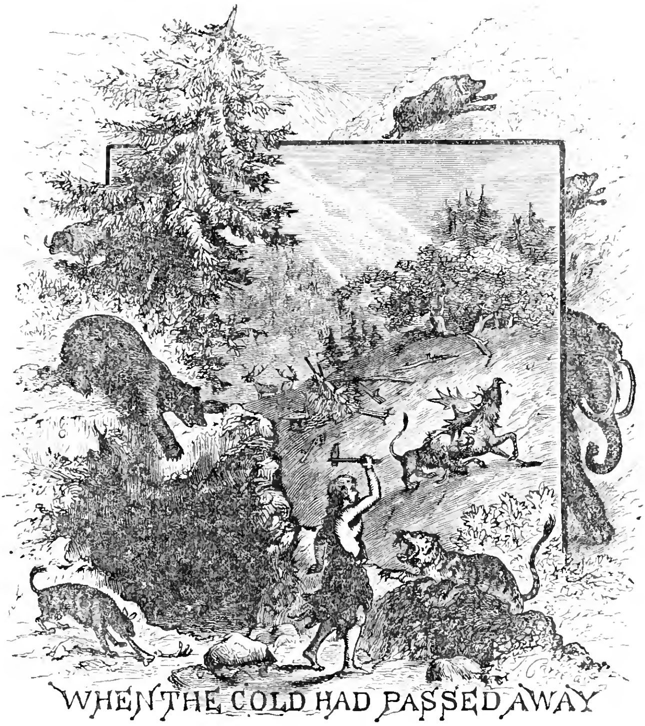

Fig. 11.

At one time naturalists looked upon the animal kingdom as complete from the beginning, and, when it became certain that different kinds of animals had appeared from time to time upon the earth, the naturalists of fifty years ago could have no grander conception than that new creatures were separately made (they scarcely asked themselves how), and put into the world as they were wanted.

But a higher and better explanation was soon to be found, for there was growing up among us the greatest naturalist and thinker of our day, that patient searcher after truth, Charles Darwin, whose genius and earnest labors opened our eyes gradually to a conception so deep, so true, and so grand, that side by side with it the idea of making an animal from time to time, as a sculptor makes a model of clay, seems too weak and paltry ever to have been attributed to an Almighty Power.

CURIOSITIES OF SUPERSTITION.

By FELIX L. OSWALD, M. D.

III.

SOME international superstitions have a symbolic significance. The vampire-fable, for instance, typifies the insufficiency of human life, the sleep-disturbing consciousness of its unattained purposes. Like the visits of the White Lady, the rambles of the posthumous night-walker have generally a definite object, the gratification of revenge or desire, or of some special crotchet, like that of the Turkish horse-ghoul (mentioned by the traveler Kohl), who amused himself by galloping the race-horses of his former master. Mental aberrations can become epidemic, and the vampire-delusion seems to be as contagious as the witchcraft-insanity. In Transylvania the "climate of opinion" appears to affect even foreigners. In 1859 an Austrian notary of Klausenburg recorded the testimony of forty-eight deponents of various nationalities, who attested the *post-mortem* appearance of one Fedor Radotzek, a brevet captain of the *Grenz-Corps*, or Military-Frontier Guards. About two years after the funeral of the brevet captain, the neighbors attended a birthday-party at the house of his widow, and toward evening some of them were standing in the open porch, talking to one of his sons, when they saw the old man himself come round the corner and enter the garden-gate. A few minutes after the garden was crowded with a mass-meeting of citizens, in a pardonable state of excitement, for the twilight was still clear enough to remove all doubts about the identity of the visitor. He had taken a seat on the garden-bench, making himself at home, as if nothing had happened; but, on being taken to task for the eccentricity of his conduct, he had the good sense to re-die on the spot, and met his fate like a well-behaved corpse, when a couple of priests took him in charge and hustled him off the premises.

Vampirism prevails all over Russia, Persia, Greece, Bohemia, and Poland, but especially in the Danubian Principalities, where the wealthy families of the last century often buried their dead in sheet-iron-lined coffins of the heaviest oak-plank, while the poor would sometimes fetter or even hamstring their deceased relatives, to prevent them from abusing their feet for posthumous excursions. It is one of the few dogmas which the Moslem share with their Christian neighbors. There is a variety of maladies, chlorosis and hectic fever, for instance, which the Turkish beldames unhesitatingly ascribe to the activity of a ghoul; and after the massacre of Chios the Capitan Pasha ordered the bodies to be burned, "lest they should leave their graves." For a similar reason, perhaps, the judges of the Holy Inquisition roasted their victims; they believed, with Aristotle, that "fire disembodies the principle of life, and restores the peace of the original elements." The Parsees worship in fire the purifying principle of Nature. Their millennium, like that of the Nihilists, will be preceded by a general explosion, a thorough actual cautery of earthly sores, and uncremated corpses will have to await the day of that final world-purgatory.

The vampire-superstition has been traced back to the earliest centuries of the Christian era, when the Nature-worship of ancient Europe had to yield to the dreary asceticism of the new creed, and the ancient divinities and their retainers had to wander homeless—in the North as followers of the Wild Huntsman, and in the South as night-hags and ghouls, like the Lamia of that weird and wonderful ballad, Goethe's "Bride of Corinth," which his rival, Heine, calls the "lyrical masterpiece of European poetry." A citizen of Corinth, a recent convert, betroths his daughter first to a young Athenian, and next to the "bridegroom of the Church," i. e., shuts her up in a nunnery, where they kill her with prayers and penances. Bridegroom number one arrives unexpectedly one evening; explanations are postponed to the next day, and in the mean time the guest is consigned to a room formerly occupied by his lost bride. During the night her mother hears stealthy footsteps and a whispered conversation, and, impelled by an irresistible curiosity, she opens the door of the guest-chamber. A vampire, caught *in flagrante*, confronts her, and she recognizes her own daughter, who, instead of collapsing at the sign of the cross, turns upon her with fierce reproaches, admits the fatal consequences of her visit, mentions other victims, but finally suggests the remedy—a Grecian funeral-pile. Her body, she says, has to be removed from the stifling cloister-vault, and cremated in due form, together with the corpse of her lover:

> "When the stake-fires blend,
> When the sparks ascend,
> Shall our spirits join the ancient gods."

In the mountains of Upper Austria the natives dread the boding voice of the *Klage*, a spectral Cassandra who frequents the desolate highlands of the Wiener Wald and the eastern Alps. He who meets her meets his death; her voice presages imminent misfortune, or afflicts the hearer with chronic hypochondria, for the echo of her wail will haunt the ear forever. A precisely analogous spook, the *llorona* (from *llorar*, to *weep* or *mourn*), infests the Sierras of old Spain, while *La Pleureuse* bemoans the sorrows of life on the French side of the Pyrenees. This concomitance of highlands and pessimism seems rather paradoxical; but mountaineers are mostly autochthones (like the Basques, Gaelic Scotch, Circassians, Ghebirs, and Druses), and may have preserved the memory of a Juventus Mundi, which lingered in their rocks, together with paganism and Ruskinian ideals.

The belief in the malign influence of the *mal-occhio*, or evil-eye, is not confined to the Latin races, but prevails in Persia and China, as well as among the South-China Malays and their East Indian neighbors. In Southern Italy the superstition is almost universal. According to the popular theory, the possessor of an evil-eye can stare his victims into all sorts of afflictions, palsy, rickets, goitre, etc. Nay, his power for evil has hardly any limits whatever, for by the same optical process he can produce death and epidemics—cholera infantum, for instance. And, moreover, such persons are generally conscious of their dreadful talent, and can forbear its exercise, for they manage to connive at their favorites. Evil-eye wizards can be known by their peculiar way of squinting, or by their bushy eyebrows, that conceal the piercing steadiness of their gaze, and orthodox crones lament the decadence of the good old times when such offenders could be brought to justice. According to the myth of the Puranas, the god Siva can blight a whole town with his withering look ; and the Indian gods, who often visit earth in the guise of mortals, are sometimes recognized by the *rigidness* of their gaze : they never wink ; to their sleepless eyes space and time are units. Hecate and Medusa had such optics, and the basis of the superstition may possibly be the primitive man's dread of mental superiority, the power of mind over matter, ascribed to the eye, as the mirror of the soul. Captain Burton noticed that the negroes of Soodan are almost unable to meet a white man's gaze, though they quail still more before the fire-eyes of their Semitic neighbors. The Veddahs of Ceylon, too, seem, to dread a Siva in every foreigner.

But the most wide-spread of all superstitions is the belief in portents. In some of its modifications the tendency to ascribe an ominous significance to certain events, and good or bad luck to be auspices of certain times or contingencies, is all but universal. It survives the influence of every other form of superstition. The elder Pliny, who calmly rejects the entire mythological system of his countrymen, admits his belief in the prognostications of the haruspices. The skeptic, Wallenstein, kept two or three professional astrologers. Napoleon the Great was a firm believer in lucky and unlucky days. The Pyrrhonist, Walid, surrounded himself with Egyptian pages on account of the "favorable auspices of their nationality. The Marquis d'Argens, the presiding atheist of the Sans-Souci symposia, after shocking even the scoffing king and the king of scoffers by the profanity of his remarks, was apt to turn pale at the discovery of a double peach-stone or the accidental spilling of the salt. French mariners have ceased to vow wax-candles to Our Lady of Brest, but they still dislike to leave a harbor on Friday, or during the progress of a hail-shower. The agnostic Chinamen (for the gospel of Confucius is nothing but a secular code of morals) postpone a journey if they meet a decrepit old woman. Certain dreams impress them so strongly with the dread of impending disaster that even opium-smokers will forego their drug for a day or two, in order to keep all their available wits about them. A Silesian miner will make his will if his lamp happens to go out before its oil is spent. According to the analysis of Immanuel Kant, the basis of the whole delusion is what he calls the *post hoc ergo propter hoc* fallacy—"after it, therefore because of it," or the tendency to mistake an accidental coincidence for the result of a causal connection. From this point of view there is no specific difference between a misapplication of the inductive method and the grossest portent-superstition. The precipitate follower of Bacon has noticed the coincidence of cold weather and catarrhs, and jumps to the conclusion that a low temperature deranges the functions of the respiratory organs; he has known cases of recovery following the use of Dr. Quack's cough-medicine, and ascribes the cure to the nostrum. The weather changes about four times a month, a month has four lunar phases, therefore the weather depends on the changes of the moon. At the roulette-table certain numbers may now and then turn up oftener than others: the gambler concludes that they must be lucky numbers, or bets on red cards because he twice lost his monthly salary on a black one. To the objection that the weather-superstition deals, after all, with fixed natural laws, and the roulette-superstition with capricious accidents, the gambler might reply that so-called accidents are only necessities in disguise.

When that disguise is practically impenetrable, the theoretical attempts to that effect speak, perhaps, in favor of an order-loving and systematic tendency of the human mind. Man is a methodical animal, and will regulate his conduct by the most fantastic rules rather than act entirely at hap-hazard. "In the game of life," says Edmond About, "men are often apt to follow a system where they might just as well play at random."

In some cases that tendency may be ascribed to a latent fetichism. In the age of faith every man had his favorite days, months, numbers, stars, colors, etc.; for all such things had their presiding deities, and their partisans, as it were, threw themselves upon the protection of a tutelary spirit. The hero of the "Cyropædia" never gives battle without sacrificing to the genius of the day and the nymphs of the surrounding rivers and mountains. Scipio Africanus used to invoke the deities of a hostile city before he brought his battering-rams into play, just as the Zooloo Caffres propitiate the demons of a new hunting-ground. It seemed the safer way—"If it does no good it can do no harm"—as the mediæval apologists justified the invocation of the patron saints, and in the same way a gambler may defend his "system" against the objections of his intellectual conscience.

The rules of such systems often suggest the influence of curious associations of ideas. In ancient Greece the luckiness of the first lunar phase was deemed so axiomatic that the Spartans missed the battle of Marathon rather than take the field before the new moon.

The two weeks preceding the *plenilunium* suggest the prime of life, when things in general progress favorably, while the subsequent half months correspond to the age of declining strength and general retrogression. The haruspices augured on the principle that a bird's flight from left to right was a favorable omen—things were going the *right* way, while by the laws of consistency the opposite direction suggested adverse tendencies. Birds, as creatures of the air, seemed the fittest messengers of the gods, who had a way of imparting their revelations by symbols, and might be supposed to choose the beginning of an unlucky enterprise as the best time for warning their favorites: When Conradin of Hohenstauffen set out for that fatal campaign that ended on the scaffold of Naples, his horse refused to cross the Arno Bridge, and an old citizen adjured him to turn back, but he dismounted and led his horse across. "It means that we are going to prevail *afoot*," he laughed, alluding to the preponderance of his infantry force. A year before the invasion of the Saracens, King Roderic saw their horses and riders in a dream; and Appolonius of Tyana foresaw even the great *aphanasia*, the fifteen hundred years' eclipse of common sense and reason. "Woe be to our children!" he exclaimed, on awakening from a trance; "I see a shadow approaching; a great darkness is going to cover this world."

After the analogy of great natural catastrophes, events of national importance were supposed to cast premonitory shadows, and in nearly every country on earth the myth-making faculty of the people has accordingly supplied a set of portents for every momentous incident of their history. Tacitus records a due number of obituary prodigies for every one of his Cæsars. The battle of Adrianople, where the clubs of the Visigoths broke the power of the Roman Empire, was foretold by an augur who had seen a portentous cloud approaching from the east in the teeth of a strong west wind. The conquest of Mexico was the fulfillment of an omen that had plainly warned the natives of their impending fate. In the night when Abderrahman el Hakim died, shooting-stars showered down as if they were going to set the earth afire. The tyrant Polycrates of Samos was born during an earthquake that shook the foundations of the island. Before the birth of Buddha Sakyamuni the Ganges flowed back to its source, flowers sprouted in desert places, a sound of music rung through the air, corpses left their tombs, and a new star appeared. A new star appeared also after the murder of Julius Cæsar, and certainly after the death of Antinous, for the Emperor Hadrian ordered it to be worshiped as the transfigured spirit of his favorite.

The *rationale* of the superior luckiness of odd numbers is less obvious, but they were certainly the favorite numbers of the Gnostics and of all mythological systems. The three Graces, three Fates, three Furies, three Judges of the dead, and three-headed hell-hounds appear as mystical as the Indian Trimurti and its derivatives. The seven sacraments, seven gates of the New Zion, and seven golden candlesticks, correspond to the seven days of the week. Lars Porsenna swears by the nine gods, and Ovid by the nine Muses. All, perhaps, for the negative reason (though *oddity* may have its positive attractions) that a deliberative junta of even numbers can not get the benefit of a casting vote. Gamblers rarely bet on even numbers; it is one of their corporation maxims, besides which every individual player has a by-law code of his own. The Spaniard Garcia, who broke every gambling-hell on the Rhine, operated upon the theory that luck, like history, repeats itself in a certain succession, and kept a list of successive hits, in order to back the same series after the turning up of the first number. Count Esterhazy, whose portentous luck made him the bugbear of the Swiss watering-places, believed in the inspiration of a first attempt, and relied on the instinct of a pointer—any novice who in consideration of a percentage would consent to locate his stakes. That the tiger-wardens themselves are not above such superstitions seems proved by the fact that the managers of the little Bath Pfeffers once offered him ten thousand francs to dig his gold from a wealthier mine.

"*Fortis Fortuna adjuvat*" ("Fortune favors the *strong*") was a Latin proverb, and Napoleon, like Suvaroff and Bismarck, asserted that she is always on the side of the big battalions, though, like their fellow-men, they probably inclined to the private opinion that "luckiness" is a special faculty, and that, irrespective of their energy, prudence, and perseverance, some people manage to score success after success. In the California bonanza period every camp had its "lucky man," not always the best mineralogist, but a fellow who somehow had a knack of stumbling upon "pay-dirt," and thus became the chosen pioneer of his comrades. It sometimes really seems as if the race were neither to the swift nor the cunning. We have merchants, speculators, and politicians, whom Fortune declines to forsake, in spite of all their blunders—*Sontags-kinder*, "Sunday-children," as the Germans call them—fellows who have six points ahead in every game and beat the best players. Where others have wasted their time in mining and counter-mining, they take every fort at the first assault, and for no apparent reason, unless good luck begets self-confidence, for pluck is perhaps, after all, the secret of every real success.

The Chinese divide all auspices into *yan* and *yuen*, male and female, positive-lucky and negative-unlucky streams of tendency. The sun is a *yan*, the moon a *yuen*, luminary; daylight blesses and vivifies; moonlight blights. For cognate reasons, perhaps, Friday (the day of Friya, *dies Veneris*) is an unlucky day: among the Romans, as well as among the ancient Saxons, it was sacred to a *female* deity. M. Quetelet estimates that the Friday superstition costs the French railway companies an average aggregate of five million francs a year, by which sum the expenses of Friday passenger-trains exceed the receipts!

If we consider the expensiveness of the Delphian oracle and the Loretto miracle-factory, the sums wasted on all kinds of amulets, from a brickbat fetich to a marble cathedral, we must admit that superstitions are costly luxuries. Dome-building, the most expensive phase of the mania, culminated during the night of the middle ages, and that night is certainly passing away, but many of its specters still frequent their ancient haunts; for supernaturalism is a Proteus, and apt to assume shapes that can not be exorcised with daylight. Like the poison-habit, the thirst for miracles satisfies its craving with a variety of stimulants. Ex-Romanists revel in mysticism, as their ancestors fuddled with the Rosicrucian Gnostics, and afterward with magic and astrology. Protestants often yield to the craving for stronger stimulants and glut it with rectified spiritism, undiluted with traditions and homilies. Mr. Kiddle's apocalypse is the confession of a moral opium-eater. In France professional free-thinkers patronize not less professional clairvoyants; the pythoness Lenormand amassed a fortune of two million francs, and was consulted by atheists and philosophers, and twice even by the Emperor Napoleon, whose speculative dogmas were limited to a few negative tenets. German nonconformists are apt to contract a passion for ghost-stories. Their publishers have regular sample-rooms of supernaturalism; Arnim's novels, a rock-and-rye mixture of romantic poetry and spook stories, have become household works; Jung Stilling's *Geister-kunde* (Spectrology), a sort of proof-spirits with a flavor of pietism, has still an enormous circulation. Men who never enter a church, and treat all sects with the tolerance of absolute indifference, procure their tipple from a circulating library, like peace-loving topers who shun tavern-brawls, but now and then purchase a quart of rum and take it home in a pocket-flask. On the whole, it is a step in the right direction. Their liquor is often as strong as anything sold across the bar, but the effects of their inspiration are limited to the precincts of a private sanctum, and they are less apt to force their poison upon their neighbors.

[*Concluded.*]

PERCEPTIONAL INSANITIES.*

By W. A. HAMMOND, M. D.

THE simplest forms of insanity are those which consist merely of false perceptions, and they are not of such a character as to lessen the responsibility of the individual. There are two forms of false

* Abridged from advance sheets of Dr. Hammond's forthcoming work on "Insanity in its Medical Relations."

perceptions—illusions and hallucinations. Uncomplicated illusions are rare; still there is no doubt that there are illusions not the results of disease in the organs of sense or of circumstances unfavorable to exact perception, but which are due to a morbid condition of the perceptional ganglia, and the unreal nature of which is clearly recognized by the individual.

Illusions of *sight* often relate merely to the size of objects. Thus, a young lady who had overtasked herself at school saw everything of enormous size at which she looked. The head of a person seemed to be several feet in diameter, and little children looked like giants. So far as her own person was concerned there were no illusions. Her own hands appeared of the natural size, but those of other people seemed to be of enormous proportions. Sauvages refers to a case in which a young woman, suffering from epilepsy, had the illusion of seeing objects greatly magnified. A fly seemed to her to be as large as a chicken. In the case which came under my observation, the unreal character of the perception was fully recognized, and hence the intellect was not involved.

Morbid illusions of *hearing*, unaccompanied by other evidences of mental derangement, are not very common. One case only has come under my observation. It was that of a gentleman to whom the ticking of a clock was resolved into articulate words. Generally the expressions were in the form of commands. For instance, if at dinner, they would be, "Eat your soup!" "Drink no wine!" and so on. One day he made the discovery that, if he closed the right ear firmly, the illusion disappeared; but, if the left ear were closed, the words were still distinctly heard. It was hence clear that the center for hearing on the right side was the one affected, and that that on the left side was normal. For a long time this gentleman resisted accepting any of these illusions as facts, but after a time he began to be influenced by them to the extent of regarding them as guides. Eventually he put clocks in every room in his house, and professed to be governed altogether by the directions they gave him.

Illusions of *touch*, as Michea says, may relate to temperature, movement, weight, and the character of surfaces. Thus, to some patients, substances that are hot feel cold, and *vice versa;* others feel the things on which they sit or lie glide from under them. Illusions of a general character as regards the whole body are quite common—giving the sensation of extreme weight or lightness, or as if the body were immensely lengthened or shortened.

As regards frequency, illusions of the sense of touch occupy the front rank; next are those of sight, and next those of hearing. Illusions of taste and of smell, except with persons who are otherwise insane, are not common. A few instances of the latter, however, have occurred within my personal experience. To one of these, a lady, everything she put into her mouth tasted like cauliflower; in another instance, the flavor was that of strong Roquefort cheese, and in another of pears.

The difference between illusions and hallucinations can be recognized without difficulty, for the latter are entirely cerebral in origin, and do not require, as do the former, a material basis. They can not be produced by any defects or derangements of the sensory organs, or by any external circumstances tending to interfere with the normal action of these organs. We have to consider them now as resulting from disorder of the perceptional ganglia without the implication of those parts of the brain which are concerned in the production of intellect, emotion, or will.

The case of Nicolai, the German bookseller, is a striking instance of hallucinations of *sight*. For ten months he had been a good deal disturbed by several melancholy incidents. A customary blood-letting was omitted, and added to all was an unusual press of business matters. One morning he suddenly perceived, at apparently the distance of ten steps, a form like that of a deceased person. The phantom continued only for about ten minutes, but in the afternoon it reappeared. He arose and went to another room, the apparition accompanying him—disappearing, however, at intervals, and always maintaining the erect posture. Later there appeared other figures, unlike the first.

After the first day the figure of the deceased person no longer appeared, but its place was supplied by many other phantoms, sometimes representing acquaintances, but mostly strangers. After about four weeks he began to hear them talk. The application of leeches to the arms relieved him promptly of his hallucinations.

Hallucinations of *hearing* are more common than those of any other of the special senses, and, according to my experience, are more apt to lead to further mental disorder. Far more people kill themselves under the influence of hallucinations of hearing than from those of all the other senses combined. The reiteration in the ears, during every minute of the day, of the command to jump into the river, to plunge a convenient knife into the heart, and so on, day in and day out, is calculated to shake the power of control of the strongest-minded.

Sometimes a single word or a few words constitute the hallucination, but in their more complex character they are sentences and even long discourses. No instance that has come under my observation equals that of a lady who hears recited to her long pieces of original poetry or prose. She has repeatedly written down these recitations and brought them to me. This lady had a strong hereditary tendency to insanity, and, shortly after the development of the hallucinations referred to, she imbibed the delusion that she had committed the "unpardonable sin." She made two attempts at suicide, and is still insane, but has—an unusual circumstance—lost the delusion of the "unpardonable sin," and contracted the idea that she has no bowels.

As hallucinations of sight often exist while the eyes are closed, or in persons who are totally blind, so hallucinations of hearing continue though the ears be stopped, or originate in persons who are entirely deaf. A deaf-mute who came to my clinique at the University Medical College was constantly subject to hallucinations of hearing. It is said that in the last years of his life Beethoven became completely deaf, but that he heard his compositions as distinctly as when he actually listened to them when performed by an orchestra.

Hallucinations of hearing, like those of sight, are sometimes unilateral—that is, heard by only one ear. Baillarger cites several examples of the kind.

Calmet gives some interesting details relative to hallucinations. In one case a M. de S—— entered his study one afternoon, and, turning toward the door to go to his bedroom again, was much surprised to see it shut and barricade itself with the two bolts that belonged to it. At the same time the doors of a large press opened behind him and rather darkened his study, because the window which was open was behind these doors. "At this sight the fright of M. de S—— is more easy to imagine than to describe; however, he had sufficient calmness left to hear, in his left ear, a distinct voice, which spoke to him in very good terms, and ordered him to do some one particular thing which he was commanded to keep secret."

Hallucinations of *smell*, though not so common as those of sight and hearing, are yet often met with. A gentleman of my acquaintance was almost constantly subject to the hallucination of smelling paint or turpentine; another had the odor of coffee ever present in his nostrils; and another, a physician, was always annoyed with the smell of the dissecting-room. It is well known that some epileptic seizures are preceded by the sensation of a horrible stench.

Hallucinations of *taste* are not common. Indeed, it is sometimes difficult to say whether they exist or not, as various visceral irregularities may cause the production of tastes by modifications impressed upon the saliva. Mental excitement will cause a like effect in some persons. I am acquainted with a gentleman who can not participate in any engrossing conversation without having a bitter taste developed in his mouth.

Hallucinations of the sense of *touch* are, on the other hand, very frequently met with. Sensations apparently not based on any real impression are experienced in various parts of the body. It is difficult, however, to discriminate between illusions and hallucinations of touch.

Occasionally persons have the power of voluntarily producing hallucinations. A practice fraught with danger, for the time is apt to come at which they can not get rid of their false perceptions. As an instance, I cite the following case from Wigan. The painter referred to is Blake:

"A painter, who inherited much of the patronage of Sir Joshua Reynolds, was so fully engaged that he told me he had painted three hundred large and small portraits in one year. The fact appeared physically impossible, but the secret of his astonishing success was this: he required but one sitting of his model. I begged him to detail to me his method of procedure, and he related what follows: 'When a sitter came, I looked attentively on him for half an hour, sketching from time to time on the canvas. I removed the canvas and passed to another person. When I wished to continue the first portrait I recalled the man to my mind, and placed him on the chair. Then I went on painting, occasionally stopping to examine the posture, as though the original were before me. This method made me very popular, for the sitters were delighted that I spared them the annoying sittings of other painters. 'By degrees I began to lose all distinction between the imaginary and the real figure; then all became confusion. I lost my reason, and remained for thirty years in an asylum.'"

It is related of Talma, the great actor, that he could cause the audience to appear to him like skeletons, and that, when the hallucination was complete, his histrionic genius was at its height.

Goethe states that he had the power of giving form to the images passing before his mind, and, upon one occasion, saw his own figure approaching him.

Several like cases have come under my own observation. In one, the power was directly the result of attendance at spiritual meetings, and of the efforts made to become a good "medium." The patient, a lady, at first thought very deeply of some particular person, whose image she endeavored to form in her mind. Then she assumed that the person was really present, and addressed conversation to him. At this period she was not deceived, for she clearly recognized the fact that the image was not present.

One day, however, she was thinking very intently of her mother, and, happening to raise her eyes, she saw her mother standing before her exactly as she had imagined her. In a few moments the phantom disappeared, but she soon found that she had the ability to recall it at will. During the spiritualistic meetings she attended, she could thus reproduce the image of any person upon whom she strongly concentrated her thoughts, and was for a long time sincere in her belief that they were real appearances. At last she lost control of the operations, and became constantly subject to hallucinations of sight and hearing.

Although no one presumes to question the honesty of Jerome Cardan, or of Swedenborg, it is probable that their visions were also induced by intense mental concentration. In some persons very slight thought is sufficient to cause hallucinations of great distinctness.

The causes of central illusions and hallucinations are generally to be found in derangements of some kind in the blood circulating in the brain. These may either relate to its quantity or its quality.

Physical influences calculated to produce cerebral hyperæmia or congestion may give rise to illusions or hallucinations. Brierre de Boismont refers to a case, on the authority of Moreau, in which an individual was able to obtain hallucinations of sight by inclining his head a little forward. A similar case was not long since under my own care. A gentleman, while sitting at his table writing, happened to raise his eyes without moving his head, and saw before him the figure of an old woman with black cloak and hood. Throwing himself back in his chair in his amazement, he found that the image slowly disappeared; and, as often as he repeated these movements, a like series of phenomena occurred. On examining him, I found that he wore a very high, old-fashioned stock, which, as he sat at the table with his head bent forward, compressed the large veins of the neck, and prevented for a time the return of blood from the brain. On changing his neck-wear for other of more modern fashion, he was enabled to bend his head and raise his eyes without encountering the apparition.

A gentleman once consulted me who, for several weeks, had seen, just as he lay down, the figure of a very old man, who stood by the side of his bed grinning and beckoning to him. At first he was deceived, and started suddenly from his bed, whereupon his visitor disappeared. He made several tests which satisfied him as to the real character of the phantom, and then, like a sensible man, tried to get to sleep, but in this attempt he succeeded badly.

The explanation of such cases is very simple. The recumbent posture facilitates the flow of blood to the brain, and at the same time tends, in a measure, to retard its exit. Hence the appearances were due to the resulting congestion. As soon as the individual rose in bed, or stood erect, the reverse conditions existed, the congestion disappeared, and the apparition went with it.

The influence of cerebral *hyperæmia* in causing hallucinations seems to be clearly established. Ferriar wrote a treatise with the special object of proving that this is the only cause. This is an extreme view, however, which can not be sustained, for that the very opposite condition, cerebral *anæmia,* is an immediate cause of hallucinations is seen in the facts that, during starvation and other conditions producing great bodily exhaustion, hallucinations are common occurrences.

A striking instance has recently come under my observation, which shows, undoubtedly, that a reduction in the amount of blood circulating within the cranium may give rise to hallucinations. A young woman affected with epilepsy had repeated seizures while in my consulting-room, and, with a view of arresting them, I exerted strong pressure on both carotid arteries. Her face instantly became pale, and, without losing consciousness, she uttered a loud shriek, and pointed at an object which she apparently saw near her. I at once discontinued the pressure, when she informed me that she had seen an immense negro rushing toward her with a club, and that as soon as I had stopped pressing on her neck the figure had disappeared. I assured her it was an hallucination, and induced her to let me repeat the experiment. I now exerted moderate pressure, with the view of keeping it up for some little time. In about half a minute she said that she saw the figure, but not very distinctly, and I found that I could make the figure appear distinct or indistinct by varying the degree of pressure.

Children are very liable to be subject to hallucinations, and frequently give circumstantial accounts of incidents which they believe have occurred to them, of voices they have heard, etc. It is often impossible for them to discriminate between the true and the false, and I am afraid they are often punished for lying by ignorant parents, when they have told nothing but what they have had the evidence of their senses for believing.

A great deal has been written relative to the physiology of hallucinations, but without much result so far as any explanation of the process is concerned. There is some evidence to show that the *thalami optici* are the centers for all real perceptions, and that hence they are the organs, which, through their disease, give rise to all centric illusions and hallucinations. Luys more than any other physiologist has elaborated this idea, and has adduced arguments in its support which it is difficult to overlook. His doctrine is that the optic thalami are reservoirs for all sensorial impressions coming from the periphery of the nervous system, and that, like other ganglionic masses, they elaborate these impressions, and that, by means of the fibers of the corona radiata, they transmit them to the cortex, to be still further perpetuated by being converted into ideas.

If there is no organ of sense, there can be no normal sensorial impression ; if the optic nerve be divided, the sensation can not be transmitted to the optic thalamus ; if there be a diseased optic thalamus, the sensorial impression will be perverted and there will be an illusion of centric origin ; if the cortex be in a normal condition, this illusion will be corrected and understood as such erroneous perception ; if, however, the cortex be diseased, the illusion will be accepted as true, and a false idea, or delusion, will be formed. Such an impression formed in the optic thalamus is an hallucination, and will be accepted for reality or not according as the cortex is healthy or diseased.

Such is, I think, the pathology of perceptional insanity. The lesions of the optic thalamus necessary to the production of a false sensorial impression may be of varied character. Congestion is probably that which most commonly exists, especially in the early stages, and in those cases which are not accompanied by derangements of the other categories of mental faculties. Anæmia is likewise a condition of frequent occurrence. At later periods, as Luys says, the optic thalami are the seats of degenerations which show that there have been frequent perturbations of the circulation. He is very strong in his conviction that there are secondary changes, which are the cause of the transformation of psycho-sensorial hallucinations into those which Baillarger designated psychic. In my opinion, they are the cause of the hallucination becoming a delusion, and, indeed, between a psychic hallucination and a delusion there is very little difference. The former can not exist without the involvement of the intellect.

DWARFS AND GIANTS.*

By M. DELBŒUF.

A BELGIAN philosopher, M. Stas, declared, two years ago, that "no science to which measure, weight, and calculation are not applicable can be considered an exact science; it is only a mass of unconnected observations, or of simple mental conceptions." I agree to this without reserve. Undoubtedly, vain imaginations and crude theories, which have form without solidity, should be banished from science; but it does not follow that we must define science as a collection of weights and measures, and calculations upon them, or as consisting of combinations of algebraic formulas from which other formulas may be deduced. These matters of weight, measure, and calculation must have some synthesis or useful purpose in view. They should throw light upon some law, and that a law which is an idea, or which is susceptible of being converted into an idea. It is the philosophic thought penetrating them that gives interest to the statistical labors of Quetelet. The cry of the positivists of the day is for "facts!" To that I oppose another cry: "Ideas! give us ideas!" A fact without an idea is a body without a soul, a useless incumbrance to the memory. I come to the defense of speculation. While I view with impatience volumes of figures, operations, and formulas, of which the signification and bearing can not be perceived, I am inclined to be grateful to the man who throws out a new idea, though it be a thousand times false. There is always more to be learned from the thinker who talks nonsense logically than from the observer who does not reason at all. From nothing, nothing can come, but error may bring forth the truth at the price of its own death.

Laying aside these generalities, let us consider an example of the

* From an address before the Royal Academy of Belgium. Translated for "The Popular Science Monthly."

way in which we can weigh and measure, submit the results to calculation, and draw from them conclusions which are formally quite legitimate, and still be all the time on the wrong track ; then examine how we may be set upon the right road, and led to a new conclusion more plausible and more in harmony with the rest of our knowledge.

It has been discovered that the flea can leap two hundred times its length. Our admiration at this is changed to astonishment when it is demonstrated by calculation that, if nature had endowed the horse with a degree of strength similarly proportioned to his weight he would have been able to clear the Rocky Mountains at a bound, and that with a like effort a whale would be able to leap to a height of two hundred leagues. What can be more unassailable than these conclusions, founded on weight, measure, and calculation ?

It is true that, if, instead of comparing the weights of the horse and the flea, we had compared their heights, we should have found that the horse's leap would not measure more than three hundred metres. Why is preference given to the weight ? Because it is its whole body with its three dimensions and its density that the flea hurls to two hundred times its height, and it is the same feat of strength that we demand in vain of the horse. Calculations have also been made to show that, if a man could move with a speed proportioned to that of certain insects, he would be able to travel more than ten leagues in a minute, or sixty times as fast as a railroad-train.

The Amazon ants, going to battle, travel from two to two and a half metres a minute. The Amazons of antiquity, to be even with them, if we judge by the relative heights, should have traveled eight leagues an hour. We have, however, in this case, to compare the forces with which given masses move themselves, and should take account of weights or volumes. If we proceed by this rule, we shall obtain formidable numbers, that stagger the boldest imagination. The warlike inhabitants of the banks of the Thermodon would have to get over fifty thousand leagues in an hour. Yet, who can deny the truth of the observations, the rigor of the measurements, or the justice of the reasoning ?

The authors of these interesting calculations have not had in mind only to make known some figures of comparison, good to store up, even if they are never used, but they have endeavored to set forth the idea that certain insects are much better endowed with powers of leaping and speed than the vertebrates, and especially than man. The persons who express this conclusion have failed to conform to the precept that they must not extract more from their facts than is rigorously contained in them, and are the victims of a scientific illusion, which is quite wide-spread, but not hard to dissipate. What is in question? It is the valuation of the labor necessary to raise a certain weight to a certain height. The labor increases in proportion to the weight and the height. When, then, two animals of different masses leap to the same absolute height, each one performs a work precisely proportional to its mass; and, when a man leaps over an obstacle sixty centimetres from the ground, he accomplishes, other conditions being the same, a task as considerable again as that of the flea or the grasshopper, which can not spring much above thirty centimetres.

A few figures will make the matter plain. Take a grasshopper weighing six decigrammes (nine grains), and a man weighing sixty kilogrammes (one hundred and fifty pounds). The man is equivalent in weight to a hundred thousand grasshoppers. But a hundred thousand grasshoppers grouped into a single mass could only raise that mass thirty centimetres, while the man can lift his own mass sixty centimetres. All the advantage, then, is on the side of the man. Here is a wide variance from the strength which has been exacted of the horse to make him a rival of the flea.

The basis of the comparison was vicious. The height or volume of the agent who handles a weight has nothing to do with the estimation of the labor. A sack of meal is no heavier on the shoulders of a man than on the loins of a horse. The labor and the effort have been confounded. The labor is a defined and absolute quantity; the effort a vague and variable sensation.

The deductions respecting speed have no better foundation. The ant, as a moving body, is a little mass of matter on which a determined force impresses a speed of two and a half metres a minute. To impress the same speed on a mass of fifteen millions of ants—which I take to represent the volume of a man—would require a force fifteen millions greater. This force is developed by a man going two and a half metres a minute, while in the same space of time he can easily accomplish a hundred metres and more. In this case, then, if we take notice of any one of the data, the man manifests a strength forty times greater in proportion than that of the ant. This is a very different result from the one arrived at by the other method. Other data, however, come in to complicate the comparison and considerably modify the result.

A little closer study of the phenomena of walking will show us that it absorbs a considerable quantity of force that does not appear in speed. It is not simply a uniform transportation of the body along an horizontal line; but at each step the body is raised, and falls again. The incessant repetition of the lifting is a great cause of fatigue. Hence, walking on an uneven road tires us greatly. In the best paths, the differences of level which have to be overcome correspond with a notable quantity of force lost from speed. The ant, however, being a creeping thing, and supported on six feet, has to raise only a very small part of its weight at each step, and is therefore more advantageously formed than the man, who, having only two feet, gives to his whole body a double oscillation—sidewise, and up and down. On the other hand, the ant feels even the slightest inequalities of the ground. When it goes over the space that represents a man's step, and requires only a single lifting of his body, it has to lift its own perhaps a thousand times. The sum of all these little lifts would probably give us a considerable one.

The conclusion we have just reached, that man is relatively forty times stronger than the ant, deserves, then, a closer examination; and it may be that the just interpretation of our facts will cause us to believe that the energetic capacity of muscular fibers is nearly uniform in all animals.

There is another illusion in these matters, which we might call psychological. The agility of some animals surprises us. The monad in a drop of water moves so nimbly that we can hardly follow it; and we naturally make a comparison between the distance which an animal can cover in a certain time and its dimensions. The reasoning of this comparison presents a problem somewhat difficult of solution. It is enough to know that we can not draw from the illusion the consequences which we like to see in it.

If I were to attempt an explanation of this agility, which gives small animals so great facility in escaping their enemies, I should look for it in the small momentum of their mass when in flight, by reason of which only a slight effort is required to enable them to change their direction. Incontestably, we can run much faster than mice; nevertheless, it is not easy to catch a mouse in a closed room. Our own mass is an impediment to our agility. By the time we have made a spring in one direction, the mouse has changed his, and we put our hand, too late, where he was. It is very hard even to lay hold of a bird in a narrow cage.

The part of our question that remains to be treated is no less arduous or obscure than that which we have gone over. I will try to throw what light is possible upon it, but I can not flatter myself that I shall fully succeed. M. Plateau some seventeen years ago measured, with the aid of ingenious harnessings and other devices, the muscular force of insects. He deduced from his experiments that, aside from the power of flight, insects have, as compared with vertebrates, an enormous strength in proportion to their weight; and that in the same group of insects the strength varies, as between different species, inversely as the weight, or, in other words, that the smallest insects are the strongest.

Some of his single results were really surprising. While a horse weighing six hundred kilogrammes can hardly support four hundred kilogrammes, or two thirds of his weight, he found May-bugs, weighing a sixth of a gramme, able to support sixty-six times their own weight, or more than ten grammes. Here, then, was a humble and stu, pid beetle a hundred times as strong in proportion as the proud and sturdy horse. Another little insect, weighing half a decigramme-could move a hundred times its weight. By this standard we men ought to be able to struggle with weights of six thousand kilogrammes (or fifteen thousand pounds), and elephants should move mountains. We can not dispute the accuracy of the experiments or the calculations, nor impeach the sincerity or judgment of the experimenter. The facts are, moreover, conformable to observations. A caterpillar in the closed hand will make prodigious efforts to open his prison; and who has not seen ants carrying things three or four times as large as themselves? Various attempts have been made to escape the consequences that were deduced from these experiments, but they still stand, apparently defying criticism. Must we, then, resign ourselves to being a hundred or two hundred times weaker than a beetle? Are insects really, in physical force, kings of creation?

Not yet. An important element has been neglected. No account has been made yet of the time it takes the insect to perform its wonderful feat. Whenever we raise a given weight to any height, by whatever method, the labor performed is in proportion to the weight multiplied by the height; and this product always gives the measure of that labor. The same product, under certain restrictions, furnishes the measure of the force that is utilized in the work. A dog is not as strong as a horse, but both animals expend precisely the same force in raising a kilogramme a metre. Whatever the kind of work he may wish to calculate, even though it be horizontal, it is always reducible to the elevation of a certain weight to a certain height, and is in practice measured by a formula of which these are the terms.

While, however, the quantity of force that must be expended for a determined work is invariable, this is not the case with the manner in which that expenditure may be distributed. If I wish to strike a single strong blow, I execute a quick movement. If my muscular power is weak, I must have more time. It is possible, then, for time to supply a deficiency of power. I can make such a substitution applicable in two ways, by dividing the resistance, or by using a machine as a lever, which, when everything about it is considered, is nothing more or less than a device by means of which we replace power with time.

Accurately to compare the strength of a May-bug with that of a man, we must take into the account the time which the insect requires to perform the work exacted of it. Suppose a horse harnessed to a load of half his weight, and a May-bug drawing a tray fifty times as heavy as itself: the beetle's load will be relatively a hundred times as heavy as the horse's. But if the horse needs only a second to raise his load a metre, while the insect takes a hundred times as long to produce the same effect, then the efforts of which they are both capable are proportionably the same. The case is the same, only the appearance is changed, when the force is spent in maintaining the weight at an equilibrium.

In a similar manner we may account for the power manifested by the insect which I cover with a board a hundred times as heavy as itself, and which gets its head under the edge, raises it, and escapes.

You know that, if we should put a horse under a bell weighing sixty thousand kilogrammes, it could not make its cover move at all. That is because the animal can not insinuate itself under the edge of the bell, and is not formed to raise weights with its head. But fix a lever under the edge so that the horse can work conveniently at its longer arm, and require him to raise the weight, not to a proportionate, but to an equal height with that to which the insect raised his board in the same time, and he would not fail to achieve the task.

The interest of the problem before us does not lie simply in learning why insects are capable of efforts which appear enormous as compared with their size. The important thing is to discover whether Nature, as has been said, has regarded them more favorably than it has the vertebrates and man, and has endued them prodigally with muscular force, while it has been parsimonious to the other animals. We need not believe anything of this kind. The prodigies of force that astonish us are due to a very simple cause, and can be accounted for under the common law that, of two muscles having the same mass and the same energy, the shorter one is capable of raising the more considerable weight. We may figure muscular fiber as a spiral spring, habitually relaxed, which, under nervous action, flies back upon itself. Suppose this fiber to be a decimetre long and capable of contracting to half its length, and that it has attached to it a weight, say, of a centigramme. Under the nervous action, it will raise this weight half its length, or five centimetres. Now, if we replace this single fiber, a decimetre long, by a muscular bundle weighing just as much but composed of ten fibers a centimetre long, we can attach a centigramme weight to each of these fibers, or ten centigrammes to the whole bundle ; but the weight will be raised, under the contraction of the muscle, only five millimetres instead of five centimetres. What we have gained in power we have lost in extent of motion. That is the rule. We have hence a right to conclude, that short muscles have the peculiarity, as compared with long muscles of the same volume, that they act more slowly but can move more considerable masses. Consequently, small animals perform, absolutely, slower motions, but, in compensation they can move proportionately heavier masses. We can thus comprehend how our insect can move masses a hundred times heavier than itself, without having to infer that it is a hundred times stronger than a horse. Introducing its head and corselet under the obstacle it desires to remove, it stretches its six legs, raises its body, and develops an apparently surprising force. Really, it has lifted the obstacle only in the slightest degree, but enough to allow it to escape. Its strength has been furnished by the short and thick muscles of its six legs and its neck. These considerations furnish the key to all the Herculean labors performed by small animals. The smaller the animal, the more capable it is of great efforts ; only it loses in speed what it develops in force. Hence the strongest insects are generally the slowest.

Let us finish our argument with an imaginary illustration embodying the principles and the consequences derived from them. An adventurous explorer, visiting the countries in which Gulliver traveled, brings back a Lilliputian and a Brobdingnagian. The giant is thirty feet high, the dwarf four inches. Since one is about a hundred times as large as the other, their respective masses, and consequently the masses of their muscles, must be in the proportion of a million to one. If a common man weighs sixty kilogrammes, or 150 pounds, the Brobdingnagian should weigh 15,000 kilogrammes, or about 38,000 pounds, and the Lilliputian only fifteen grammes. They agree to compete with each other in the gymnasium. At the pulleys, the Brobdingnagian can easily raise a weight of 10,000 kilogrammes, or 2,500 pounds, as high as his shoulders. Looking to the Lilliputian, we would at first sight not expect him to be able to raise more than ten grammes to his shoulders. He really proves able to lift a hundred times as much, or one kilogramme, or the equivalent of seventy-five times his weight. This is because the distance to his shoulders is a hundred times less than the distance to his rival's shoulders, and he is able to apply against the weight the advantage which he derives from the relative shortness of the distance.

They next try leaping at the bar. The Lilliputian gracefully clears the pole at a metre from the ground. Will the Brobdingnagian be able to make a bound of a hundred metres? Not at all. He can hardly clear the bar at five or six metres. This is not because he is lacking in suppleness. Compare his mass with that of his little rival, consider that he has raised the center of gravity of that mass to the height of about a metre as the other has done with that of his inferior mass, and it will not be hard to do justice to his agility.

They are next started on a foot-race. A course of a thousand metres is laid out. The Brobdingnagian runs it in five minutes by steps of four metres each per second. The Lilliputian's steps are only four centimetres each, but he makes a hundred of them in a second; so he likewise goes over the track in five minutes. You give all praise to the Lilliputian, but do an injustice to his competitor. Think of what the giant has to do to move his legs! They are a million times as heavy as the Lilliputian's. But while he may have a million fibers, or a thousand in the diameter of a transverse section, the Lilliputian will have ten fibers in the corresponding diameter, or a thousand in all. Thus, while the masses are in the proportion of a million to one, the proportion as to the motive fibers is a million to a hundred. The Lilliputian, then, has the advantage. It may be objected that a hundred steps can hardly be made in a second. The objection is, however, only specious, for the wings of insects show us what is possible in this matter.

We are authorized by the aid of these illustrations to draw the important conclusion that the minute world is not, and can not be, in all respects a proportional reduction of a larger world. There is an impossibility in the matter which I can only indicate, but which depends on the constitution of time and space.

If the views I have expressed are true, we have a right to infer that all animals as to their energy stand upon the same line, or, in other words, that a muscular fiber possesses the same properties, whether it belong to a vertebrate, an articulate, or a mollusk. Such a conclusion is more satisfactory at the first view than those which I have criticised, for our mind is fond of discovering unity and uniformity in nature. I am not certain that it is exact. That can be determined only by experiments. The question is now put into the hands of investigators who are endowed with the genius for patient and minute researches. Let them attack it with their instruments of observation and precision. The arguments they will deduce will be those before which we shall be forced to bow.

The main object of my remarks has been, however, to plead the cause, which in these days has been somewhat compromised, of Speculation, the mother of ideas, which allures us more frequently than it instructs us, but which stimulates, guides, and pushes us forward, and sometimes gives us a glimpse, if it does not permit us to contemplate them, of brilliant and grand horizons.

THE CENSUS AND THE FORESTS.

By N. H. EGLESTON.

THE prudent and thrifty tradesman once a year takes an account of stock, and thereby assures himself as to what goods he has in possession, as well as what gain or loss may have accrued to him as the result of the year's transactions. So the nation, or, if we please to use the figure of personality, "Uncle Sam," deems it wise occasionally to take an account of stock; only this is done but once in ten years, and is called "taking the census." It could not well be taken oftener. The process is too long and too complicated. The reduction to tabular form of the millions of facts and items of information, the summarization of the particulars gathered from so many States and Territories, require no small amount of time, even with the best arrangements for facilitating the performance of the work. The results of the census of 1880 are not yet officially before us. Some facts as to population, the gross number of people in a certain range of cities and towns, and a few other facts of special interest or importance, have been communicated to the newspapers, and thus have become known to the public. But not a single volume of the thirty which the census report is expected to make has yet appeared.

Nor if we could have a more frequent census would it, perhaps, be desirable. We should not have time to become acquainted with the facts ascertained by one census, and to see their bearing upon our life and present occupations, before another census would be at our door with its claims upon our attention, because possibly necessitating some important change in our plans or pursuits.

With the growth of the country, the census constantly becomes a greater and more complicated matter. It was a comparatively simple affair at first. It was little more than the enumeration of the population of the country, for the purpose of apportioning direct taxes in the several States, and also the representatives in the national Congress. For the latter purpose the respective numbers of whites and blacks were given, three fifths of the latter being counted, during the existence of slavery, in determining the quota of representation for each State.

A noticeable fact in regard to the census of the United States is, that it is the result of a constitutional ordinance, the very first article of the Constitution providing for a general enumeration of the population within three years from the convening of the first session of Congress, and again during every subsequent decade. The first census was consequently taken in 1790. It gave the names of heads of families, the number of free white males above and below sixteen years of age, the number of females, and the number of slaves. Subsequent censuses have extended the classification so as to give the number of persons of any specified age, from one year upward to a hundred, and in recent years various other particulars. In 1810 the marshals were directed for the first time to make returns of the manufactures and manufacturing establishments of the country. So, from time to time, the census reports have embraced new facts in regard to the people and the products of their industry.

The ninth census, that of 1870, was much more full in this respect than any that preceded it. It gave not only the numbers of the people of all ages and the sexes, but their occupations and the products of their industries, as they had never been given before. Perhaps no country had ever had its material and social condition, its resources and productions, so fully presented to view as were ours by this census. With the experience gained in its compilation, and the satisfaction which its fullness had given, the census of 1880 was undertaken with the design to make it still more full and complete. Among other subjects to which special attention has been given in taking the tenth census is that of our forests. Hitherto the forests have been looked upon chiefly as the source of lumber-supply, and the census has taken account of them only so far as to report the statistics of the lumber-trade, and some of the industries connected with it or derivable from it. But the importance of the forests at once appears when we consider that the census of 1870 reported the annual value of sawed lumber produced by our forests as $210,159,327, and that there were 63,928 establishments engaged in the manufacture of articles made entirely of wood, besides 109,512 establishments in which wood is an important part of the material used—as in the manufacture of carriages, agricultural implements, etc. It has been estimated that the value of the products annually drawn from our forests exceeds $1,000,000,000, and of the vast imports of Great Britain two thirds are said to be of vegetable character. Such facts show at once the very prominent place which the forests of the world hold among national interests. But, in addition to the bearing of the forests upon the mechanical industries of life, they have an important relation to climate and to the meteorologic conditions on which agriculture and commerce and the health and life of the people depend. When all these things are taken into account, as until recently they have not been, it becomes at once apparent that no subject, perhaps, deserves more consideration among the resources of a country, and that the special attention given it in the compilation of the present census is abundantly warranted.

Accordingly, the endeavor has been made to ascertain, with more completeness and precision than ever before, the situation of the country in respect to its woody covering; to learn to what extent the several States and Territories abound in trees in masses; of what species of trees the forests are composed, their location, and their commercial and industrial value. The work of ascertaining these facts, and presenting them in proper form as a part of the census returns, was committed by the Department of the Interior to Professor C. S. Sargent, of Harvard University, who is also manager of the Arnold Arboretum at Brookline. In carrying out the work assigned to him, Professor Sargent divided the whole country into several districts, each of which was given in charge to one or two competent persons, with the needful assistants, for the purpose of making a personal examination of the districts, and also ascertaining facts by correspondence with residents of different parts of the districts, so that a sufficiently exact report might be made in regard to the timber-growth of the country. Professor Sargent personally undertook the exploration of the Pacific division, including California, Oregon, and Washington Territory.

The result of this forest survey will be to give us a knowledge of the species and varieties of trees indigenous to our country, with the districts where they most abound, and where they attain their best development. It will show us what our forest resources are, whether for the production of lumber, or fuel, or for ornamental planting. It will show how far and how fast our forest supplies are diminishing, and from what cause or causes; whether from the axe of the lumberman, estimating the forests according to the number of feet of boards or timber which they will yield, or from the axe of the woodman or the miner; whether from the fire kindled by the pioneer, eager in the quickest way possible to clear a space in which to cultivate his wheat and corn, and pasture his herds, or from the fire lighted recklessly or by accident by some passing huntsman or traveler.

In showing the relative position of our forests in respect to land elevation and the vicinity of streams, the census report will show the relation of the forests to the water-supply, and consequently their influence upon agriculture and manufactures. It will indicate their influence upon rain-fall and climate, as well as upon the course and effect of winds, whether considered in their mechanical or their meteorological relations. It will have an important use also as indicating the relative healthfulness of different portions of our wide and diversified domain.

In prosecuting his study of our forests, Professor Sargent has gathered a large collection of specimens of the different woods. These will show the natural appearance of the trees, and the variation of appearance and texture caused by growth under differing circumstances of soil and climate. From these specimens portions have also been taken and carefully worked down so as to show the grain and the susceptibility to polish, and their consequent value for mechanical and artistic purposes. The beauty of our native woods, and their adaptation on this account to the manufacture of cabinet-work, and to the interior finish of dwellings, will be made to appear as never before, and will be a surprise to many. It will be seen that we have gone abroad and procured materials for cabinet and carpentry uses at great expense when our own forests stood ready to supply all that the most fastidious taste could require. Professor Brewer, of Yale College, reports that there are probably 800 species of woody plants indigenous to the United States, of which 250 attain a height of thirty feet, and are abundant in some portion of the country.

Careful experiments have also been made in order to determine the relative value of our woods for the purposes of construction and for use as fuel. Blocks and sections of a great variety of trees have been selected, reduced to the same dimensions, freed to an equal extent from moisture—in other words, brought, so far as possible, to the same conditions—and then subjected to treatment at the United States Arsenal at Watertown, by means of nice and powerful machinery, in the hands of careful manipulators, for the purpose of determining the respective amounts of resistance to a crushing and a fracturing strain.

Similar pieces have also been burned, under like circumstances, as nearly as possible, and the amount of heat developed by their combustion accurately determined. The relative value as fuel of the different kinds of wood with which our country abounds has thus been ascertained. Probably no more trustworthy and decisive experiments have ever been made for the purpose of showing the value of different woods for the uses of construction or as sources of heat.

One of the peculiar and, practically, most valuable features of the census report of our forest resources is the attempt made by Professor Sargent to give at a glance, by means of maps, the history and present condition of our woodlands throughout the country. In the census of 1870 maps had been used for the purpose of showing the distribution of our native and foreign population, the greater or less degree of illiteracy in different portions of the country, and the areas of land devoted to the cultivation of the great staples, corn, wheat, and tobacco. The vital statistics were also, to some extent, reduced to the map form, and the deaths from consumption, fevers, and some other classes of diseases were presented in the same way.

In the census report now in preparation this plan of presenting classes of facts at once through the eye by means of maps is applied to the woody covering of the country. More especially, the object has been to show the present extent of the supply of pine-timber, as being of chief importance in connection with the lumber industry of the country, and so bearing, more or less directly, upon many other interests and occupations. The hard-woods, also, where prevalent to any considerable extent, are of course denoted on the maps. Otherwise, their amount and localities are briefly described in the accompanying text of the report.

In general, one map is devoted to each State or Territory, though in the case of Vermont and New Hampshire the two are grouped together. The maps are carefully prepared, and the engraving and printing in colors are such that the eye perceives at once in what portion of any State or Territory the supply of pine is undiminished, and where and to what extent it has been cut off. It is also made apparent at once where the pine has exclusive possession of the soil, and where it grows mingled with the hard-woods.

In connection with the maps, but on a separate page, the statistics in regard to the lumber-supply are given in properly arranged tables, these with the corresponding map constituting a "Forestry Bulletin." The first of the Bulletins to be printed was that relating to the "Pine Supply of Texas," and a brief description of this will show the method pursued in all. The map of Texas is on a scale of one hundred miles to the inch. The water-courses are given with great completeness, and the county lines as far west as the one hundredth parallel. The map is so printed in colors as to show the parts of the State abounding respectively in the short-leaved or loblolly pine (*Pinus tæda*) mixed with the oak and other hard-woods; second, those abounding in the short-leaved or yellow pine (*Pinus mitis*), mixed with oak and other hard-woods, together with a little loblolly pine; third, those abounding in the long-leaved pine (*Pinus Australis*), and, fourth, the regions from which merchantable pine has been cut off. A glance at the map shows that Texas is poorly supplied with pine-timber, the entire State, with the exception of the few eastern counties, being uncolored, which indicates the absence of trees in any such numbers as to constitute a forest. It is evident also from the map that in ten or twelve counties there is a considerable growth of the long-leaved pine, and in perhaps twenty or twenty-five counties a good deal of the two species of the short-leaved pine mingled with various hard-woods. But in seven eighths of the State there is not sufficient pine to be indicated at all on the map.

Turning now to the statistical tables accompanying the map, we find the estimated amount of merchantable pine standing at the date May 31, 1880, was as follows: long-leaved pine (*Pinus Australis*), 20,508,-200,000 feet, board-measure; short-leaved pine (*Pinus mitis*), 26,093,-200,000 feet; loblolly pine (*Pinus tæda*), 20,907,100,000 feet.

It will be noticed that the estimated amounts of the various kinds of pine found in Texas do not vary greatly from one another. The amount cut during the year ending May 31, 1880, of the long-leaved pine, is given as 66,450,000 feet; of the *Pinus mitis*, or short-leaved, 146,420,000 feet, including 30,290,000 shingles; and of the loblolly pine, 61,570,000 feet.

The amount of pine standing in the counties which have pine at all varies from 19,000,000 to 3,216,000,000 feet each.

From this description it will be seen that from such a simple Bulletin, with its map, any one can learn in a few minutes very accurately the condition of the lumber interest in any part of the country.

It will not be amiss, perhaps, to compare for a few moments the first Bulletin, that of Texas, with the sixth, that of Michigan, the two representing regions widely separated and differing also in climate, while the latter has been, until quite recently, one of our chief sources for the supply of pine-lumber. The area of Texas is about five times as great as that of Michigan. The Upper and Lower Peninsulas of Michigan are given upon separate maps, which are on a scale of forty miles to the inch. The engraving and coloring are such as to indicate portions abounding respectively in hard-wood, in pine, in pine and hard-wood mingled together, the portions also which have been cut over, whether of pine alone or of pine and hard-wood mixed, and the barrens.

A glance at the maps shows at once that the lower portion of the State, for a distance of sixty or seventy miles from the Ohio border, is covered with hard-wood, except as it has been cleared for agricultural purposes. Above this a broad belt stretches across the State, in which pine and hard-woods have grown together, but in which the pine has been mostly swept off by the lumberman's axe, and so thoroughly swept off as to leave no corresponding growth to follow it in future years, and the greater part of the hard-wood has also been destroyed. In the northern part of the Lower Peninsula some pine remains, but it is apparent that the axe has felled nearly all that grew in the vicinity of the streams, so that what little is now standing is reached only by means of railways built especially for the purpose of transporting it to market.

Looking at the map of the Upper Peninsula, the eye sees instantly that the pine-forests remain only in a comparatively small district bordering on the northern portion of Wisconsin and not easily accessible, while from that part of the State lying along the Menominee River and Green Bay, as well as along the upper shore of Lake Michigan and the southern shore of Lake Superior—in short, wherever they could be reached with facility—both the pine and hard-wood have been cleared away. There remains a belt of mingled pine and hard-wood stretching across the interior of the Peninsula, and a section, consisting chiefly of hard-wood, lying in the extreme northern and northwestern portions.

These grand facts in regard to one of the principal sources hitherto of our pine-lumber are seen at a glance from the clear and well-defined maps of the forthcoming census report. Apart from such a presentation to the eye, they could not be gained without much and careful inquiry, and then the facts would make no such clear and distinct impression upon the mind as they do at once when thus mapped before the sight.

The rate at which the supply of lumber in any region is increased or diminished can not be given by a single map, or the relation of the supply to the annual demand. These facts could be presented to the eye only by a series of maps showing the areas of forest as they become changed from year to year. So, in a single page of figures accompanying each map, we have the estimated amount of merchantable timber still standing on the 31st of May, 1880, and the amount cut during the year ending with that date. The comparison of these readily gives the probable duration of the supply at the present rate of consumption. Thus the statement for Michigan is as follows: In the Lower Peninsula the amount of white pine is:

	Board-measure.
In the basins of the streams flowing into Saginaw Bay....	7,000,000,000 feet.
In the basins of streams flowing into Lake Huron........	8,000,000,000 "
In the basins of streams flowing into Lake Michigan.....	14,000,000,000 "
Total..	29,000,000,000 "

Cut for the census year ending May 31, 1880, including 2,988,600,000 shingles and 428,445,000 laths, but exclusive of 36,000,000 staves and 3,330,000 sets of headings, 4,068,773,000 feet.

It will be seen at once that, at the present rate of consumption, the white-pine lumber of the Lower Peninsula will be consumed in about seven years. It will probably last somewhat longer than this, because its increasing scarcity and the increased difficulty of procuring it on account of its remoteness from streams by means of which it might be easily floated to market, will advance the price, and thereby lessen the demand for it. The duration of the remaining pine-forests of Michigan will also be extended by the fact that the augmented price will lead to the substitution of the hard-woods for many purposes in the place of pine. We see every day that the hard-woods are coming into use more and more for the interior finish of buildings, as well as for many other applications.

There is in the Lower Peninsula an estimated amount of 575,500,000 cords of hard-wood distributed over nearly 20,000,000 acres. About twenty per cent of this is suitable for lumber and cooperage stock. There were cut for the census year ending May 31, 1880, exclusive of 163,821,000 staves and 18,567,000 sets of headings, and including 6,038,000 feet of spool stock, 440,944,000 feet.

In the southern half of the Lower Peninsula the forest has been largely removed for agricultural purposes or used in manufacturing, although considerable wooded areas generally distributed still remain. In the upper part of this Peninsula the hard-wood is now being rapidly consumed in the manufacture of charcoal, to be used for the purpose of smelting the iron-ores with which that region abounds.

Passing now to the Upper Peninsula, it is estimated that the amount of merchantable pine-lumber still standing is 6,000,000,000 feet. There were cut for the census year ending May 31, 1881, 328,438,000 feet. The supply here, at the present rate of consumption, would last about eighteen years.

Of hard-wood there is an estimated amount of 124,500,000 cords, distributed over 10,000,000 acres. There were cut for the census year, exclusive of fuel and railroad-ties, 1,145,000 cords. The southern counties contain large areas of swamp covered with tamarack, white and yellow cedar, estimated in the aggregate at 62,500,000 cords.

We have not undertaken to give the full results of the census, even in respect to our forests and forest products. We could not do so, in the present incomplete state of the returns. We have only endeavored to indicate in advance some of the interesting and valuable results which may be anticipated from the publication of the census returns in regard to our forests and woodlands whenever that publication shall be made. We have sought to exhibit the method adopted in compiling the census, as showing the confidence which may be given to the results presented. Without doubt, under the careful management of Professor Sargent, with his able corps of assistants, we shall have set before us in the two volumes of his special report, with the accompanying maps, a great body of most interesting and important facts in regard to the present and prospective condition of our forests. We shall know, as it was not possible to know before, their value as sources of lumber and fuel, and for various uses in the arts. We shall know, as we have not known before, the various agencies by which the forests are destroyed, and the rapidity with which their destruction is effected. We shall learn, as we have not learned before, that, wasteful as is the process of converting our forests into lumber, more of our precious woodlands are destroyed by fire than by the axe. It has been ascertained, for instance, that in the comparatively small State of Massachusetts more than 14,000 acres of forest, valued at more than $100,000, have been recently consumed by fire in a single year; and in Pennsylvania 685,738 acres of forest are reported as burned over in 1880, with a loss of more than $3,000,000. We shall learn that the axe and the flames together are consuming our forests so rapidly that we are threatened with great evils on this account in the not distant future. Trees are quickly felled and quickly burned; they are slow to grow. The lumberman's axe can destroy in an hour the oak or the pine which has gained its stature and its worth only by the annual increments of a century. The spark from the tobacco-pipe of a careless tramp may kindle a flame which will speedily spread over some great mountain-side and sweep away the forest covering which has been growing ever since the beginning of our history as a nation. Great revolutions may come in our national life, and generations of men will pass away, before that forest covering can be replaced.

The forthcoming census report will show that we have 25,708 establishments for converting the trees of our forests into lumber, that $181,186,122 are employed as the needful capital for carrying on this work, and that the value of the lumber produced is $233,367,729.

The revelations of the census will show with new clearness that, in view of the rapid destruction of our forests and the evils threatened in consequence, there is no time to be lost in taking measures to avert those evils so far as possible. What measures in particular should be adopted it is aside from our present purpose to show. It is enough to say in general that we should do all that we can individually, and by legislative enactment where necessary, to prevent the further needless destruction of our remaining forests. We should be more careful and less wasteful in cutting them for the production of lumber. We should guard them more vigilantly, and, by the enforcement of severe penalties if need be, against those chance fires which result in evil, and evil only, without any incidental good to any one. We should encourage the reproduction of forests, by leaving a sufficiency of seed or mother trees on the ground where the forests are cut, and by carefully excluding from all such grounds the cattle, whose teeth and hoofs together are almost as destructive as the axe or the flames. It is impossible to grow valuable forests where cattle are allowed to range in them and browse upon the tender trees. In Europe, they have decided long ago that the woods are no proper pasture-grounds for cattle.

Finally, we should encourage the planting of many new forests on what are practically the waste lands of many of our States. Such lands can thus be made the most productive, pecuniarily, of all our lands, while in those States and Territories which are comparatively destitute of forests no land is too good to be devoted to this purpose, and no labor of the husbandman promises so important and so profitable results as that of tree-planting on the large scale. The "Northwestern Lumberman," Chicago, in its review of the lumber product for the present year, says, "To own a saw-mill to-day, with ten years' supply of standing timber, is to have that which is far better and safer than a gold-mine in the Occident." The same paper also says: "The amount of timber cut from the forests of the Northwest" (meaning Michigan, Wisconsin, and Minnesota, chiefly) "in 1881, counting that made into shingles with the lumber, exceeded 7,000,000,000 feet. It requires some little grasp of the subject to comprehend such an enormous sum. Loaded on cars, green, it would make a train nearly seven thousand miles in length. The amount of money required to purchase it from first hands would be not far from $125,000,000."

With such statements relative to the consumption of our existing forests, from authoritative sources, and the well-known fact that the price of all kinds of lumber has greatly increased during the last ten years, while that of some kinds has doubled, there should be little doubt that, looked at as a pecuniary venture alone, tree-planting on an extensive scale will bring a sure and abundant reward to those who engage in it.

ORIGIN OF THE DONKEY.*

By C. A. PIETREMENT.

THE majority of modern naturalists have long attributed an Asiatic origin to the domestic asses. They have believed that the species are derived from the so-called *onagras* or wild asses of Asia, which the ancients mention, and which are still met wandering in droves of greater or less size, from the northern part of the Altai Mountains to the southern regions of the continent. As late as 1862, Isidore Geoffroy Saint-Hilaire assumed that the primitive country of the ass was partly in Asia, partly in Africa, because, he said, "the onagra extends from Asia to Northwestern Africa." In 1869, however, M. H. Milne-Edwards considered it "well demonstrated that the ass is essentially an African species, which occurs in Asia only in a domesticated condition; and that all that the ancients, and modern travellers as well, have said of the wild asses or onagras of Syria, Persia, etc., is applicable to the *hemippus* and other varieties of *Equus hemionus*, and not to *Equus asinus*. The horse, on the other hand, appears to have originated in Central Asia and a part of Europe. It is presumable that the domestication of the ass was effected in Africa, probably in Upper Egypt or some neighboring country, and that of the horse took place in the region occupied by the Indo-Germanic peoples. If the civilization of Central Asia and Europe had much

* From a new work, "Les Chevaux dans le Temps prehistoriques et historiques" ("Horses in Prehistorical and Historical Times"). Translated and abridged for "The Popular Science Monthly."

preceded that of Egypt, we might have presumed that the Egyptians received trained horses from abroad before taming the ass that lived wild in their land; but nothing authorizes us to suppose that this was the case. In all probability, the Egyptians made use of the indigenous species, or the ass, before they did of the horse, an exotic species that never came to Africa till it was domesticated.

M. George, in his "Études Zoologiques," brings evidence corroborative of these views. Real wild asses are now found, according to him, only in Abyssinia, where they have the slate-gray color and the cranial peculiarities typical of the species.

The name by which the Semitic peoples call the ass, *hamar* (ancient Assyrian, *imeru*), a name signifying red or bright fawn color, is applicable to the hemione and not to the ass, and indicates that, confounding the two species as modern naturalists and travelers have done, they gave to the introduced animal the name which they had long applied to the similar but not identical native animal. M. Sanson was therefore right in calling the Oriental domesticated beast the Egyptian breed, or *Equus Caballus Africanus*. M. Sanson has also made a distinct race, the European, of the asses which are native to the Hispano-Atlantic center; and, as their restricted geographical area leaves no doubt that their original home was there, the propriety of this distinction can hardly be called in question. Many documents also indicate that no race of asses is native to the northern regions of the old continent. Herodotus, Aristotle, and Strabo, all speak of the absence of asses from Scythia and Northwestern Europe, and account for it by the severity of the climate, which, they say, the animals are not able to endure. They were perfectly familiar with that part of those regions which lies north of the Black Sea; so their testimony as to that part is decisive. In the time of Diodorus, three hundred years after Aristotle, horses were employed in the transportation of tin from the shores of the British Channel to the mouth of the Rhine; and this indicates that asses were still unknown or rare in that part of Gaul. There is evidence, however, that the ass had been acclimated in the time of Aristotle in some of the most temperate parts of Central Europe; for Frontin, in his "Stratagems," tells that Atheas, King of the Scythians, a contemporary of Philip of Macedon, being at war with the Triballians and hard pressed, sent around his whole unarmed population, with the asses and cattle, to appear on the rear of his enemies and cause them to believe that he was receiving large re-enforcements.

Even now the ass does not live in, by any means, all of the northern part of the Eastern Continent. Ujfalvey says that the animals live and breed at Semipalatinsk, where the temperature falls to 15° below zero, but that at Omsk they are "fancy stock," and are kept alive only with great care; and he gives statistics to show that asses and mules are very few in comparison with horses all through Turkistan, there being only twelve of them to 415,660 horses in the coldest and most mountainous government of that country.

We do not know when they were introduced into China; but it is related that the Emperor Ling-ti (168–189) made them fashionable at his court instead of horses. The Abbé Huc says that they thrive in Thibet and the northern provinces of China. It is, however, certain that they were not domesticated by the Proto-Mongols, the ancestors of the Chinese, in Northern Mongolia; and there appear to be few or none of them now in that country; for travelers speak of large flocks of sheep, goats, cows, camels, and horses, but never mention asses.

There is no probability that the Aryans were better acquainted with this animal in their original home than the Proto-Mongols in theirs. The ass is not among the animals offered in sacrifice by the heroes of the Avesta, and is only mentioned once in that book. At the time the Mazdean law was given, the Iranians were in possession of Northern Persia, where the ass had been introduced, and had been captured by Tiglath-pileser I.

The ass was taken to India very early, and the law of Menu leaves no doubt of the antiquity of its use among the Hindoos. It, for example, prohibits a Brahman from reading on an ass; declares that the Chandêlas and Swapâkas shall have no property but dogs and asses; and orders Dija, who had broken his vow of chastity, to sacrifice a dark or black ass to Niwiti, and to wear its skin, begging for a year, and confessing his sin, in seven houses every day.

Asses appear to have been in use among the Hebrews from the time of Abraham; in Assyria and the neighboring countries from the time of Tiglath-pileser I, and in Greece from the time of Hesiod, who mentions the custom of castrating mules; and Homer compares the rage of Ajax with that of an ass rushing wildly through the fields. The great Harris papyrus, describing one of the conquests of Rameses, speaks of the chiefs of Tonoutu as arriving at Coptos with their tribes, and bringing with them caravans of asses and men. In the same document, Menephthah I, relating his victory over the Mashonash and the Libyans, describes the "vile chief of the Rebu" as losing all his goods and precious things, and "everything that he had brought with him from his country, his cattle, his goats, and his asses."

The most ancient instances of the application of asses to useful purposes were in Egypt. A bas-relief in a hypogeum of Gizeh, of the date of the fourth dynasty, represents two droves of asses; and M. Lenormant remarks: "As to the ass, we see it figured on the Egyptian tombs as far back as we go. It is frequently represented in the tombs of the ancient empire, at Gizeh, Sakkara, and Abousir. The beautiful bas-relief on the tomb of Ti (fifth dynasty), representing a group of asses, of which a model was exhibited by M. Mariette at the Universal Exposition of 1867, has certainly not been forgotten. From the time of the fourth dynasty, the ass was as widely diffused in Egypt as it is now. In the tomb of Shafra-Ankh, at Gizeh, is an item of a drove of seven hundred and sixty trained asses among the assets of the deceased, who was a high functionary of the court of the founder of the great pyramid. In other tombs discovered by M. Mariette, but not yet fully described, I have remarked cases of proprietors who boasted the possession of thousands of asses. . . . Furthermore, the facts on this subject derived from the study of the monuments were not peculiar to Egypt only. . . . In the paintings on the tomb of Noumhotep, at Beni-Hassan-el-Kadim, may be seen the arrival of the family of Aamou, that is, of the nomadic shepherds of the Semitic race, who came to establish themselves in Egypt under one of the first reigns of the twelfth dynasty (about 3000 B. C.). Their only beasts of burden are the asses that carry their goods and children."

Although asses are thus frequently figured on the ancient monuments of Egypt, no representation of the mule has been found there, not even on the numerous monuments built after the horse was introduced. The people had already a good stock of camels and asses, and their soil was not of a character to call the work of mules into requisition; and mules are still scarce in Egypt.

On the other hand, the Assyrians have left us but few figures of the ass; but numerous representations of mules appear in their bas-reliefs, where these animals are plainly recognizable by their ears and horse-tails.

The first mules in the East were probably produced in those regions of Asia lying between the Ganges and the Mediterranean littoral of Syria, a short time after the arrival of the first Mongolian immigrants into these countries, where, through their residence, the Asiatic horses and the African or Nilotic asses first met. It is, then, not surprising that the legends carry the existence of mules in Assyria back into fabulous times. The cuneiform inscriptions, moreover, furnish certain and quite numerous facts attesting the antiquity of the existence of mules in that and the neighboring countries.

The use of mules was condemned by the Mosaic law, and was not adopted among the Israelites till after the priestly power had been subordinated to that of the laity by the establishment of royalty. The most ancient mention of these animals among the Israelites refers to the mules on which the people of the tribes of Issachar, Zebulon, and Naphthali brought provisions to Hebron for David, after the death of Saul (1 Chron. xii, 40). After this they are frequently referred to.

The mule is mentioned in the Veda; and Strabo says that the Prasii, on the banks of the Ganges, had them at the time of the voyage of Megasthenes to India.

Herodotus tells of the mules which Cyrus had to draw his water-wagons on his march from Persia to the siege of Babylon, and relates a curious story of one of the mules attached to the expedition of

Xerxes against the Greeks. The markets of Tyre, in the time of Ezekiel, were supplied with mules by the people of Togarma, or Armenia. According to Diodorus, Alexander, after the siege of Persepolis, brought from Babylon, Mesopotamia, and Susiana, a multitude of pack and draught mules and three thousand camels, with which to take away the treasure from that city; and, when the body of Alexander was taken from Babylon to Egypt, "four tongues were fixed to the chariot, and to each tongue a train of four yokes, each yoke composed of four mules, the whole forming a team of sixty-four mules selected for their vigor and spirit." Homer furnishes a number of evidences of the antiquity of the existence of mules in Asia Minor and Greece, and in one place declares them superior for certain purposes to oxen.

Not only do we possess fewer ancient facts respecting asses and mules than respecting horses, because their part in history has been less important, but the historical documents on asses and mules permit us to trace their past further back in the East than in the West, and this is easily explained. In the first place, the habit of preserving the memory of facts arose earlier in the East than in the West; and, in the second place, our facts relative to the Western ass are derived chiefly from the Latin authors, whose references are less exact, because they were apt to include in a lump under the designation of *jumenta* all the kinds of pack and draught animals, horses, asses, mules, oxen, and camels, that composed the baggage-trains of the armies whose exploits they related.

It is, nevertheless, true that the domestication of the European ass must have dated from a very ancient time; it must have followed very shortly the importation into the Hispano-Atlantic center of the use of dolmens and arms of polished stone. M. Boucher de Perthes has found in the peats of the Somme, some fifteen or sixteen feet below the level of the stream, an equoid skull, which M. Sanson has recognized as that of an African or Nilotic ass. The animal to which it belonged, or one of its ancestors, must have been taken there by man.

Only a few documents support the probability that mules existed in Southwestern Europe in very ancient times. Varro says that the senator Axius bought a stallion-ass for four hundred thousand sestertiæ, or $16,800. Columella's treatise on agriculture bears witness to the importance of work with mules among the Romans. This accounts for the high prices that were sometimes paid for particular stallions, for the species was neither rare nor new in Italy. The earliest mention of a mule in Rome, with a definite date, is that of the animals that drew the chariot in which Tullia rode over the body of her father Tullius after he was assassinated, B. C. 534.

The histories of the Roman wars contain several incidents in which mules appear to have been used in the army on a large scale, and of stratagems in which they were made to play a prominent part: as when the consul L. Papirius Cursor, making war upon the Samnites, frightened the enemy with the noise of a drove of them rushing down the mountain and dragging large limbs behind them ; and when Julius Cæsar, in the civil wars, prevented the Pompeiians in Spain from decamping by marching his mules with a great bustle by their camp, and making them think that he was retiring.

Our historical citations show, then, with great probability, that the two asinine races are natives of hot countries, the one of the region of the Upper Nile, the other of the Hispano-Atlantic center. For this reason they are difficult of acclimation in cold regions, while they are better able than horses to endure the torrid temperature of the diamond-regions of Southern Africa. Furthermore, the African or Nilotic ass was diffused from a very ancient period over a geographical area which extended at least from the Ganges to the Atlantic Ocean, while the European or Hispano-Atlantic ass has hardly got beyond the boundaries of his original country. The history of asses, then, as well as that of horses, testifies that the ancient migrations of civilization did not start from the western part of the continent.

SPECULATIONS ON THE NATURE OF MATTER.*

By HENRY HOBART BATES, M. A.

THE nature of matter is still almost as unknown to us in its essence as it was to the ancients, since in its minute structure it lies far below the range of the senses, or of instrumental appliances, and, therefore, beyond that direct experimental field so necessary in furnishing primary conceptions to the mind. From the impossibility of originating entirely novel ideas (which would amount to creative power), we are forced to combine and recombine such conceptions as we have, derived from experiences within that excessively small portion of the scale of being within the ken of our perceptions and faculties. This perceptible scale has been somewhat extended in both directions by refined modern instrumental means, and thus the number of elementary concepts has been slightly increased, while precision has been added to those already in possession, by stricter modes of analysis.

The field, however, is still largely speculative. It might, therefore, seem unprofitable and unscientific to labor in it, were it not for the urgent necessity for and great value of some working hypothesis, however crude (if on the road to truth), as an aid and stimulus to further progress. Without hypothesis, we can not interpret or collo-

* Read before the Philosophical Society of Washington, January 27, 1883.

cate such facts as we gain; while, without facts, we can not improve our hypothesis.

The great trouble about matter is to find out how much of it and what in it is material. Strange to say, there is nothing on which philosophers are less agreed. Unfortunately, our notions of matter are derived solely from sense impressions; and that form of it which most impresses the senses is the most encumbered with fugitive and non-essential properties. We can not say with certainty whether these properties are positive or negative.

When upon a clear summer's day we gaze outward into a cloudless sky, we look apparently into clear and void space, except for the deep-blue diffused light. We recognize vacuity. Even while we gaze, perhaps a light, fleecy cloud forms itself before our eyes, and we form the concept of the creation of a material object. We know that it is not a mere apparition—it is a form of substance. Properties begin to be recognizable in it. It reflects light—it displays color—it moves. Should its development progress, we shall have still further evidence of its substantiality. It will grow darker and more dense. It will exhibit gravity, and descend in liquid drops or solid flakes, and these portions in turn will exhibit the typical properties, qualities, and reactions of matter.

Now, what elicited this bundle of realities out of apparent nothing? A mere local refrigeration—a flaw of nothing tangible—abstracted something from the invisible potential occupant of the space, reduced its volume, sapped its mobility, its power of holding its own, and properties began to appear. Death began its work, and, as the animus fled, the skeleton framework came within our ken.

We might rise by analogy from the nimbus to the nebula—from the terrestrial to the cosmical—and see with imagination's eye a similar inverse evolution producing the apparition of things substantial, which may be really but the *intaglio* of the realities. For that which consists merely in the negation of something can not be the truest substance. An ulcer is not more material or real than the healthy tissue before the latter gives urgent call for recognition of its actuality by inflammation, incipient degradation, and advancing dissolution.

It may be possible, however, to corner a reality by the reverse process. A fair type of matter is our block of ice. It is sufficiently substantial, and loaded down with properties. A simple exposure to different temperature conditions causes its sensational properties to drop off like old clothes. We soon come to a pair of invisible and intangible existences, investigable by indirect means only, of which sufficient knowledge has been gained to establish their discontinuous or corpuscular character, as imagined by Democritus.

This molecule we must take as the representative of matter; for all masses of it, whether gaseous, liquid, or solid, are but aggregations of similar corpuscles. We can only pursue it with the eye of the imagination; for, as has been shown by the molecular physicists, its dimensions are so inconceivably minute as to far transcend the mechanism of vision, since it would require at least twenty thousand in a line to occupy a medium wave-length of light.

But could the molecule even be magnified to visible and tangible dimensions, with a new light to view it by, it could not by any means be rendered visible, either in whole or in its parts, on account of its incessant and marvelous activity, both interior and translatory. That the gas-molecule did not get its interior motion from the heat of dissociation is certain, for, on being allowed to recombine, it yields up its translatory activity, and with it as many degrees of temperature as disappeared in accomplishing the dissociation. No means of wholly destroying the interior motion are known. By some *savants* it is regarded as primordial and ultimate. It is highly probable, for reasons which Mr. Taylor has pointed out,* that the hydrogen-molecule contains at least four pairs of revolving elements, revolving in different periods, and in contractile orbits, but with periods as undeviating as those of the moons of Mars. It is in the revolving or vibratory constituent of this couple that we seek the final essence of matter, though perhaps not to arrive at it. We must not endow it with gratuitous attributes, but it is surely an entity of some kind, having, in the first place, persistent and regulated motion. Secondly, it has inertia, or mass—the property of conserving *vis viva*. Thirdly, it has some bond with its fellow by which the motions of both are modified by a constant stress according to a definite law of distance, and this, following Newton, we call attraction. Fourthly, it has the complex property of interchange of momenta, accompanied by that of conserving and compounding motion by angular rebound upon an indefinitely near approach, which we name resilience, or repulsion. Dimension it need not have, nor any other property of masses; but nobody has ever yet succeeded in getting rid of the above four. This is not universally recognized, however, and the recent controversies of philosophy are owing to the strenuous attempts to reduce the number, especially of those called occult. Motion being in our ordinary experience a result, has not been so classified, and indeed has only more recently been recognized as primary. It is with causes that philosophy seeks to deal, and in our experience causation is a chain. Primordial motion, however, is as occult and mysterious as static force.

One class of philosophers, recognizing the self-existent character of motion, has exhausted ingenuity in the effort to deduce attraction from it, of course wittingly or unwittingly bringing into co-operation the occult force inertia, to obtain *vis viva*. Another class would deduce all motion from attraction: while in the attempt to contrive a mechanism to explain resiliency—the most incomprehensible of all in a body without parts—immensely greater complications and difficulties

* Annual Address before the Philosophical Society of Washington, 1882, p. 24.

have been introduced. Inertia, so far as I am aware, has always been accepted as an inscrutable fact, or ignored.

An entity with four unexplained properties is regarded as still a long way from satisfactory simplicity. But a more important consideration is that the entity is always found associated with its fellow or fellows in a dependent and artificial way (when identified at all), which indicates an advance from primitive independence and simplicity. The complexity of the simplest atom we know of has already been referred to. The resemblance of the atoms to manufactured articles was pointed out by Sir John Herschel; and not only that, but they resemble articles made in quantities by machinery, all exactly alike, like Waltham watches or Springfield guns. And the fact that any recognizable atom, like that of hydrogen, for instance, is always exactly the same thing, whether derived from the ocean or the coal-measures, or from the occluded gas of a meteorite, or inspected in the sun and stars, as pointed out by Maxwell ("Encyclopædia Britannica," ninth edition, article "Atom"), would seem to indicate that it must be the result of an undeviating process, and in its ultimate derivation made up of finally discrete entities, and not out of continuous substance, whatever that may mean. The fact, too, of its occurrence at such wide points of distribution, indicates the unity of the present scheme of evolution, as well as the great antiquity of its origin, and its persistency of type.

We have at present no clew to the evolutionary history of the atom. The atom I distinguish both from the ultimate particle without parts, and from the complex derivative molecule of the chemical elements, such as all those we know of are. In fact, these must also be distinguished from the still differently organized compound molecule of the chemical combinations, which can be taken apart, and the enormously complicated system of the organic molecule, as of oil or albumen, which, if a body so simple as iron contains more than seven hundred couples, must contain rotary elements which can only be numbered by millions.

The atom, or elementary couple, is conceived as having dimension, figure, and polarity, and also perfect elasticity, by reason of its harmonic vibration. We have to seek an origin for it if we are at all impressed with its artificial and evolved character. Its artificiality lies in its rotary motion; such motion being due to and maintainable only by a composition of forces.

The weight and ponderosity of matter have proved a stumbling-block to the conceptions of the later philosophers—especially after Newton had generalized them as attraction and inertia—far more than the equally unexplainable property of resistance, though why, it is difficult to say. Lucretius found no such difficulty with the conception of weight, for his corpuscles all naturally tended "downward," so uncosmical were his ideas. Le Sage revived and modified the hypothesis of Lucretius, especially to get rid of the (to him) inconceivable notion of gravity. Those kinematists who follow Le Sage do so with the same avowed motive. Another school, with the same view, have revived the continuous notion of matter; out of which they have constructed an atom which has permanence and elasticity, but no avowed occult affection except inertia. It has not been further developed.

The difficulty in accepting the fact of gravity seems to be a metaphysical one, though even the metaphysicians have not held that conceivability is a criterion of objective truth. The irrelevancy of this objection has been well stated by Mr. W. R. Browne, in his article on "Central Forces" ("London, Edinburgh, and Dublin Philosophical Magazine," January, 1883, page 40), as follows: "I am not aware that the term 'unthinkable,' which is a new one, has ever been defined. Until it has been, it is impossible to say whether action at a distance is unthinkable, or whether the fact of a conception being unthinkable is sufficient reason, or any reason, for holding it to be untrue." The many instances of unthinkable truths within our familiar knowledge will readily recur to all in illustration, as, for instance, the infinite extension of space, the infinite approach of asymptotes, the nature of interminable series, etc. In fact, all forms of absolute knowledge are unthinkable. The refusal to recognize this form of knowledge has led to much heresy in other branches of exact inquiry—even in mathematics. The sentiment, however, such as it is, has led to many ingenious and futile devices in the branch we are now considering—among others, the invention of the vortex atom, before referred to.

The vortex atom belongs, not to physics, but to purely mathematical concepts; being an ideal abstraction—as much so as a surface, or a line, or four-dimensioned space—invented for the purpose of investigating problems in hydrodynamics. A homogeneous, incompressible, continuous, perfectly mobile but not miscible substance is an impossible entity, and it would seem an inconsistent one as to mobility; and, if vortex motion can not be destroyed in it, it is equally true that no means can be devised for originating it. An occult force had to be attributed to it, after all, as mass. Helmholtz, its inventor, discussed it as a purely mathematical problem; but its British adopters, struck with the remarkable attributes deduced from the postulates, set it up as the basis of a kosmos. By a similar appreciation, when that characteristic product of British genius, a modern plow, was carried to India—the land of theosophic contemplation—its enthusiastic foreign admirers, after having been carefully shown its merits, and instructed in its use, were found to have erected it in the center of the field as a god!

But, though we have no need of the hypothesis of an ether to explain away the weight of matter, especially since no such invention has been so perfected as to prove particularly successful for the purpose, the establishment of the ether with any demonstrated properties might aid our conceptions of matter, and be concatenated with it as one of its higher forms. Maxwell has pointed out ("Encyclopædia Britannica," ninth edition, article "Ether") that, though many ethers have been proposed for various purposes, none have survived except that which was invented by Huygens to explain the propagation of light. Evidence accumulates for this hypothesis, in some form, for we have no other way of accounting for the facts, but the mechanism is still a mystery.

The very property of the supposititious ethers which is so fatal to all explanation of a static stress, like gravity, namely, the requirement of time for their functions, qualifies them so far as a vehicle of radiant manifestations. Were it not for the transmission of radiant energy in specific time, doubtless it would be far simpler and more satisfactory to explain the whole effect as *actio in distans*, under the necessary law of conservation, or on the Cartesian principle of contact. The phenomenon of electro-magnetic induction—which is believed to occur between the earth and sun, as a real material effect manifest in converted energy, and yet acting in lines transverse to the lines of transmission, and apparently simultaneous—even now outstands as unexplainable in any other way, for its mechanism certainly can not at present be comprehended. Nor is the mechanism for the transmission of the radiant forms of energy yet clearly made out, though some postulates about it having consistency and probability have been laid down. The fact that something supra-material is necessary and probable on other grounds gives encouragement to the idea that a basis for the atom can eventually be found.

The ether has been conceived under four principal modes of structure, all fashioned out of our concepts of matter. Two of these are static, and two kinetic. The first is the pseudo-concept of a continuous, colloidal plenum. This is a metaphysical, not a physical, concept ; derived from an idealization of a false observation of matter which can not be realized consistently in thought with what is postulated of it afterward. As Maxwell happily remarks about the notion of homogeneous and continuous matter ("Encyclopædia Britannica," ninth edition, article "Atom"), "it is in its extreme form a theory incapable of development."

The second concept is that of a solid. This has been assumed as a conceivable way of accounting for the very high co-efficient of elasticity required by the undulatory theory, and also for the transverse mode of transmitting vibrations exhibited. The word "solid," however, can not have any meaning such as we ordinarily attach to it ; and under any signification it is admitted that the theory is encumbered with several difficulties, some of which have been set forth by Professor G. G. Stokes, in his "Report on Double Refraction" ("British Association Report," 1862, p. 253).

Thirdly, the ether has been conceived to be the ordinary elastic gases or atmospheres freely expanded into space. But these have no co-efficient of elasticity sufficient to give them such expansion, and they would be liable to condensation and compression by their own gravity about the planets, which would cause a rise of temperature and dissipation of energy which would rob the ether of its permanent character. Besides, Maxwell has shown that our atmosphere expanded into space would be far too rare in the interplanetary spaces to satisfy the required conditions; nor is there any molecular velocity at all adequate to the propagation of wave-energy with the velocities observed, as will be shown further on.

This brings us to the fourth concept, which is that of a pure primordial gaseous plenum, of sufficiently high tension, and in the condition assumed by gases in a rarefied receiver, where the mean path is so long in proportion to the mean distance that a symmetrical movement arranges itself, according to the law first pointed out by Maxwell as a corollary from the equilibrium of pressure observed in confined gases, and the performance of gases in a rarefied space first observed by Crookes, that particles in free collision in space tend constantly to rearrange their motions automatically so as to move uniformly in all directions in radial lines from every point. With the gases experimented with the mean path at normal pressure and density is very short (only about $\frac{1}{260000}$ of an inch, when the molecules have a mean distance from each other of $\frac{1}{70000000}$ of an inch), but, at the extreme of rarefaction which we are able to effect (about $\frac{1}{1000000}$ of an atmosphere, when the distance of the molecules is still only $\frac{1}{70000}$ of an inch), the mean path rises to about four inches; and C. T. Preston has shown ("Nature," vol. xxiii, p. 463), that could we carry the exhaustion to the third power of that obtainable, so that the distance of the molecules apart should be so much as one seventh of an inch, the mean path would be raised to 60,000,000 miles, since it increases in the triplicate ratio with the distance. But with the ether no such rarity need be postulated, since mean free path is but a question of size of molecule, and in comparison with the hydrogen-molecule the size of the particle can only be infinitesimal. It is clear, however, that, with the enormous velocity due to the particle, all the effect of continuity would be produced, so far as vision is concerned, by a mean distance apart, not merely of one seventh of an inch, but of many miles.

We may therefore assign to the ether any required free path, and any necessary density, tension, and velocity, all of these latter being imperceptible to molecular structures which float in and are permeated by it. The motions also of molecules in a gas so constituted would be practically as unaffected as in free space, since it is demonstrable that the resistance to motion offered by a medium such as the hypothesis calls for would be in the ratio of the motion of the moving mass to that of the particle of the medium, which in the case supposed would be excessively small, the velocity of the radiant particles being equal *at least* to that of the transmission of light.*

It is clear that, by the use of the term "free path" by the inventors of this form of the ether, its particle had already been tacitly endowed with the ocult properties of inertia and resilience. Primordial motion was also attributed—an occult factor, which, with the other two, constitutes and conserves energy.

Such an ether serves to explain the phenomena of light, and the other radiant modes of energy, better than any other yet proposed. It, therefore, measurably serves its purpose. Prior to its invention, we had only—first, Newton's hypothesis of corpuscular emission, instantaneously propagated with explosive violence at an enormous but still uniform velocity, in all possible directions, in radial lines, which still were able to fill space at all points to unlimited distances—infinite and impossible results from a trivial cause; secondly, we had Huygens's scarcely more credible hypothesis of undulations, propagated, with the same instantaneous and uniform velocity in all directions, from a luminous point in a pervading statical solid or fluid medium—another infinite effect from a trivial cause. But by the hypothesis of its own independent linear motion, ever conserved—the parasitic energy alone being transferable, and by a mechanism different from the translatory motion—many difficulties are got over. The conservation of the linear motion is due to the law of radiant matter above stated, and also, I conceive, to another consideration, which tends to prevent the bombardment of the molecules, and consequent rise of temperature and distribution of energy, so fatal to the gravitation theory. It is that the only obstructive portion of the so-called material atom (which I have named the elementary molecule) lies in the extreme boundary; and even of this it constitutes only such fraction as the ratio which the dimension of the component particle bears to the semi-circumference of the atom, which is an infinitesimal ratio. The component, having a dimension and velocity of an order comparable with that of the ethereal particles themselves, can protect itself from collisions by a readjustment, without rise of temperature, on the same terms as obtain with ethereal collisions. Collisions, however, would be excessively rare—as much so as those of the particles among themselves—and an occasional collision could not destroy the atom, owing to the peculiar bond of the component with its fellow; but its motion would be merely compounded into a gyration. The real field

* The velocity would really be at least one third greater. It has been shown, by a calculation of Maxwell's ("London, Edinburgh, and Dublin Philosophical Magazine," 1877, p. 453), that, in a gas constituted as assumed, the velocity of the wave-motion would be to the velocity of the particle in the ratio of the $\sqrt{5}$ to 3; that is, about ·745+; which would give a velocity for the ethereal particle of nearly 250,000 miles per second. It is highly probable, moreover, that some forms of electrical radiant energy surpass light in velocity of transmission.

of attraction and bombardment would be the void focus of the disk, toward which the resultant of all the forces in the ring would tend, as a corollary from the deduction from synchronism that the force which binds the atomic couples varies directly as the distance, instead of as the inverse squares.

In its passage through the disk-atom the ray takes up and conserves the dropped motion as a transverse vibratory motion of some kind; or, as Maxwell styles it, "some vector property which does not interfere with the motion of translation" ("Encyclopædia Britannica," ninth edition, article "Ether"), and which it can impart again to the revolving systems of atoms through which it travels, in an inverse mode to that of its derivation. The invention of the mechanism of this vector motion has its difficulties. I consider, first, that the radiant energies are not exhibited in matter, except upon a certain degree of disturbance, showing itself in a violent clashing of systems, either from the forming of new combinations or from incandescence resulting from the accession of energy from without or within. These clashings disturb the equilibrium of the atomic orbits, and occasion their rapid deformation by harmonic vibration in elliptic orbits whose rectangular axes rapidly alternate from major to minor while the agitation is kept up. Now, the circular movements of the components do not disturb the uniform transit of the linear ray; but the rapid approach and recession of the components in passing through the violent elliptical transitions cause a rapid alternation of stress in the field of stress through which the rays pass—since the stress varies as the distance of the components—causing a vibratory deflection of the stream of particles, due to the variation of the attractive force, in all rays except the polar ray, and in the plane of the ray normal to the plane of stress. Since the disk-atoms lie in all planes, we shall have transverse vibrations in all directions; but, if the rotating disk is gyratory, as would be the rule and not the exception, the identical ray would receive a vector or corkscrew motion, similar to what is called for by observation. The amount of deflection I take to be the index of refraction of the molecule.

It may seem unaccountable that the whole ray should undulate from passing through a single locality of oscillatory disturbance, being composed of discrete and unconnected particles; but we may compare the parallel phenomenon of a jet of water, forcibly ejected to a great distance through a hose-nozzle, which exhibits to the eye similar undulations when the source of discharge is slightly and rapidly oscillated.

It may also seem incredible that any orbital movements could be permanent enough to sustain oscillatory vibrations of such inconceivable frequency as those which luminous rays are known to execute; but I have computed, from the probable dimensions of the hydrogen-molecule as assigned by the molecular physicists, and an orbital velocity due to an ethereal origin for the components, that many hundreds of revolutions must occur for each transverse oscillation or elliptical deformation.

In its passage through other disk-atoms in equilibrium which are in harmonic tension with the vibrating ray (and therefore not diathermal or transparent), I conceive that the vibratory ray is able to invert the process and agitate the diaphragm of stress of the system, as a fish-line does the surface of a pool; thus setting up an inverse commotion and vibration of orbits due to accession of motion, accounting for the effects of reflexion, the absorption and conversion of light into sensible heat, and the chemical and actinic and electrolytic effects observed. The diverse nature of some of these effects may be due to the extremely diverse character of the vibrations, both of the disks and of the rays; e. g., the polar ray, which would have a pulsatory vibration.

The primitive gas would not, any more than our own elementary gases, experience any difficulty in holding its own, and maintaining equilibrium forever, under any ordinary state of diffusion, by reason of its perfect elasticity. But with emerging matter, or crippled ether, among other properties gravity becomes apparent; and though hardly sensible, at first, yet within the enormous cosmical aggregations of this novel drift, pressure and condensation would ensue at some point so great that in the absolute cool of space the critical point of endurance would be overcome, and some molecular systems would cripple and collapse, with the resultant liberation of their motion and clashing and agitation of the neighboring systems known as rise of temperature. The falling in of others would follow and increase the commotion, causing local expansion, and currents to a region of less pressure—sometimes, no doubt, with enough velocity to carry them entirely into free space, and beyond the control of the system.

It would be futile to attempt here to follow out all the complex consequences of this initiated evolution, but it is clear that the temperature of the whole aggregation must rise until, at the outer boundary, where alone the liberated energy was able finally to escape, the temperature must stand constantly at the heat of dissociation of the particular element or elements being evolved at any stage of development. But radiation would proceed only at the rate allowable by the nature of the combinations going on at a specified stage, though it would be practically constant for long periods, as the supply of motion could be extricated. The aggregation could not become a simple cooling body while molecular mobility remained.

Amid all this commotion and lavish escape of energy on the wings of the ether, not one particle of matter is lost. It can not recover its linear motion. It joins in the dance that is going on, and contributes to swell the molecular weight of whatever system of molecules is being evolved at that particular stage of development.

The absolute synchronism exhibited under all amplitudes of vibration by the disk-atom indicates the same law of central force as that of the pendulum in its synchronous forms, or the spring-governor; and if attraction be the bond, it is a similar law of attraction, namely, directly as the distance. This is the Newtonian law of gravity within the homogeneous sphere, and thus by actual demonstration the attractive atom observes the same law as would the earth were it penetrable—namely, the inverse squares of the distances within the sphere.*

The identity of the radiant particle with the component of the atom is inferable. It possesses the requisite properties of mass and resilience, and sufficient linear motion. Whether it should also have attraction imputed to it as inherent depends on whether that property in the molecule, where alone it is observed, is derived from the particle. If not, the latter needs only mass to conserve its deflections and its course under the first law of motion, and resilience to secure its compensatory readjustment in equilibrium. Even if possessed of gravity, the enormous proper velocity of the particle would render such an affection totally undiscoverable, because the Newtonian curves of the second order resulting from the composition of force could be nothing less than hyperbolas, whose branches would be wholly undistinguishable from straight lines.

No means at present offer themselves for suggesting how such a discontinuity of action as is implied by the change from simple linear motion to the balanced movements of the atoms could have occurred; and especially how a law of attraction according to inverse squares of distance, which we must postulate, could change for one so extraordinary as that observed within the atom, namely, directly at the distance. The law referred to rather resembles that of our summer whirlwinds, wherein the centripetal force, i. e., the pressure from without due to the rarefaction within, seems to vary directly as the centrifugal force, and therefore as the radius, until equilibrium of rotation is established. These also display a species of attraction within the vortex; and some forms of matter—as iron—evince a similar polar attraction at sensible distances when rearranged by vortical motion. But such a theory does not commend itself by that simplicity which we should expect in the region of the atom.

The evolution of the atom or elementary molecule from the particle, even if real, is not continuous with the present order of nature within our observation, and need not be, any more than the formation

* This parallel holds good only for the balanced couples themselves, in which I have assumed the cause of the stress to reside. The intensity of the stress would not vary as the distance from the center for a third body, as in the permeable sphere, but the field would be like a strained elastic *tympanum*, with varying tension dependent on the separation of the elements. The mathematical discussion of this field of force would be most interesting, involving, as it does, the investigation of all the phenomena of refraction and reflexion.

of a storm-cloud is a continuous process in the atmosphere, or the appearance of a rash in the human patient is continuous. But the cataclysm once accomplished, a new uniformity must have supervened, and evolution proceeded from that point continuously from the simple to the more heterogeneous, in accordance with strict dynamical law. Even now the history of such evolution is as plainly to be read as the history of the growth of plants in a forest. Some of the nebulæ give evidence of being collections of the simplest primordial gases, or mixtures of such, by the simplicity of their spectral lines. Even in these, radiant energy is being set free, or we could not know of their existence. We also know that the sun and stars are tremendous laboratories for the organization of matter, where disused motions are liberated in torrents. The creation of molecules in gradually increasing complexity seems to go on by discontinuous steps or stages, in accordance with the discontinuous and discrete nature of the elemental factors; and its products at each certain stage are all duplicates, whether in this sun or that. Every increase in complexity apparently liberates motion, which, by the law of conservation, must escape as an efficient agent. With the constant escape of energy, however, solidification finally ensues, as our planet bears witness, and the mobility of the molecules practically ceases. Gases and moisture, however, remain over to supply mobile conditions, and the work goes on. At this stage new supplies of sufficient temperature from without are capable of reversing the process to a degree, restoring mobility, and introducing new modes for the play of affinities. The radiant energies of the sun supply for our planet the extraneous motion necessary to carry the complexity of the molecule higher than the simple running down of matter can do, and we have the chemistry of the carbon compounds. Aided by some discontinuous step, which we can not as yet identify or explain, vitalized functions appear. The wondrously compound molecules of the tropics are evolved, oils, starches, sugars, spices, ethers, and alkaloids—magazines of stored-up *vis viva*—and, by the assimilation of these, physiological phenomena in sentient beings are carried on, accompanied by the mysteries of will and consciousness, and the still more unaccountable facts of succession and heredity, which mock, if material, all efforts at conception or comprehension of matter in its ultimate essence.

The actual amount of energy stored up in the elementary molecule is not calculable, but it must be enormous. The amount of motion can not be certainly known, for we do not know whether any could have disappeared at the birth, and the mass or atomic weight of the ultimate particle can not be known by any means now in possession. The great rapidity of oscillation across the small orbit has been vividly illustrated by G. J. Stoney ("London, Edinburgh, and Dublin Philosophical Magazine," August, 1868, page 132), by the consideration (since numbers convey no idea) that they bear the same ratio of frequency to a second of time that a second (or a wave of the hand) bears to 30,000,000 years—one of the geologic periods, during which a race of animals may have been evolved and have perished.

Such inconceivable velocity of rhythmical motion in the elementary molecule points to some cause more potent than the action of any mere static force combined with any mere energy of position. The same is true of the more complex molecules of our experience—say of iron, or calcium—displaying hundreds of spectral lines. We can not suppose these inconceivably energetic motions to have been all set up by any mere precipitation which evolved the element, nor to have existed in their present organization from eternity. The same is, of course, true of the organic molecule. Their conserved energy lies in the vast reserve of *vis viva* stored up in their complex interior movements. A few ounces of organized food suffice for the expenditure of a mountain-climber for a whole day. An apparently inert explosive is traversed by a tiny spark, or pressed too closely, and the increased swing of one molecular orbit sets off the whole mass into new paths and more economical relations by which a vast amount of motion is liberated, to appear as temperature. This temporarily expands the whole mass many volumes, but, as the agitation subsides, the now surplus energy dissipates by radiation, and, being picked up by surrounding bodies, temperature becomes equalized. This mechanical modification and distribution of motions, resulting in final equilibrium, is more intelligible than the instantaneous setting up of immense velocities and momenta by precipitation from a state of absolute rest.

Besides, research proves that there is absolutely no room for any such energy of position as was fancied. Sir William Thomson has shown, by considerations of high probability ("Nature," vol. i, page 553), that the distance from center to center of molecules in solids and liquids can be but little more than the diameter of the molecules. In liquids, from their great resistance to compression, the practical point of contact has been reached, but temperature conserves mobility.

The phrase "dead matter," once deemed so eminently characteristic, now seems absurd. To deprive matter of its inherent activity is indeed one of the most difficult problems we can encounter. To do it, some means for the disposal and transfer of its energy must be provided. Until very recently, no means were contrivable for subduing the elementary gases, but, by resorting to the most extraordinary compression, in conjunction with the lowest temperature procurable by artificial means, the feat has been accomplished. There is a way, however, of pitting certain elements against each other by taking advantage of their commensurate atomic periods, and in this way we get our chief supply of artificial heat. This is due to our fortunate store of carbon and hydrogen, free and combined, and of uncombined oxygen. The known distances of the molecules of the gases above named under normal temperature and pressure give no clew to the enormous amount of energy liberated by their combination under any supposable attraction—certainly not under any that is observable.

We are, therefore, compelled to recognize the latent energy in matter. The kinematists were profoundly impressed by this now established fact, and, as is the usual tendency of the promulgation of any brilliant discovery, they undertook too much with it—to wit, to construct a kosmos.

By a similar tendency, after the establishment of the laws of motion, and of universal gravitation, followed by the discovery of the conservation of matter, and later by that of the conservation of energy, and the perception of the energy of position, these brilliant advances in knowledge of the absolute had encouraged the hope that the ultimate could be explained. Matter was then viewed almost entirely in its statical aspect—as is even now too much the case, for we still see in our chemical text-books molecules absurdly represented by geometrical diagrams—and, from the fact that motion *does* actually result from attraction and position, it was natural to relegate motion to the category of effects. There were, then, but two factors in the problem—matter, and its occult affections. But as matter they took the old "dead matter," in the last gasp of its evolution, freighted down with its bundle of inert properties of negation, and, to evolve a universe, simply credited it with its virtue of position, and left it to the action of the weakest of its affections, gravitation, to run over again a short portion of its normal course.

Even then, the surprising result appeared that it would galvanize itself into life with activity enough to supply the radiant energy which our sun now exhibits for a period of some 20,000,000 years. This, whether we follow the meteoric hypothesis of Mayer, or the contraction hypothesis of Helmholtz, which have been held to be the only conceivable hypotheses. How sublime the solution of the problem could we, in the place of these *cinders*, put into the mathematical mill the true data! James Croll, in groping for some adequate data to explain the duration actually needed for the exhibition of solar energy of which we have evidence, suggests (" Climate and Time," page 353) that, on dynamical principles, given two masses each one half the sun's mass, moving directly toward each other with a velocity of 476 miles per second, sufficient heat might be accounted for to cover an emission at the present rate for 50,000,000 years. The surplus velocity, over and above that due to gravity, he derives from stellar proper motion; but, while the supposition is violent and unphilosophical, both in respect to the large proper motion assumed, and particularly as to the assumption of direct collision, in the plurality of cases called for by the multitude of suns, the result is still grossly inadequate. The problem is insoluble from pure dynamical considerations. They take no heed of the most important factors—elementary specific heat, elementary affinities, elementary motion. When we once succeed in legitimizing the conception that suns and stars are evolved, not out of *débris*, and weak statical force, but from the primordial plenum itself, equipped with latent power in equilibrium, we can view them as they apparently are—perennial fountains of energy—incandescent lamps of eternity—drawing their supplies from the mysterious stoppage of primordial motions, with the accompanying evolution of chemical elements, and the radiation of liberated energy in torrents.

Energy of position is undoubtedly a factor, among others more important, in an evolving nebula or sun. It should be given its due value, but no more. There is evidence to show that even the translatory motions of suns and worlds can not be wholly accounted for by gravity alone. This is furnished by the large proper motion of some of the stars, particularly the notable instance of 1830 of Groombridge's catalogue, with a linear velocity of at least two hundred miles per second, if observations are to be trusted. An analysis by Newcomb proves conclusively that all the stars of the visible portion of the universe, and all the possible dark masses which could exist there, are widely incapable either of furnishing a star with such an amount of motion, or of stopping it.

The recognition of kinetics, then, in conjunction with dynamics, is what I desire to call attention to, in our philosophical attempts to extend our generalizations. We need to take note of all the forces and factors which we can perceive; and even then it is probable that our field of inspection will be too restricted to yield a satisfactory insight into that which was born from eternity. But that should not induce us to settle down on a "good enough universe" for finite comprehension, nor plead for boundaries to the infinite and eternal. Some mathematicians have invented a space cut down to finite comprehension. The trouble with these finite infinities and limited universes is, that they do not satisfy the mind, nor the definitions.

Although the course of the present order of creation is far longer than can be assigned or imagined, and, even as to our solar system, illimitable as measured by our cycles, no doubt it runs its course, for we can see the evidence of progressive change. The struggle for the elimination of energy in its entanglement with mass is a fiercer and more protracted one than we dreamed of, but it goes surely on to its termination. The energy by which the small vehicles were possessed escapes by slow dissipation back into the great storehouse of equilibrated power whence it was arrested, as gases return to the parent atmosphere from the rotting wood of the forest. The molecule is never finally taken apart, that we can see. The skeleton-heaps, in rigid and icy bonds, wander forever as *débris* and dust through the streams of space. Their amount, however, is so infinitesimal compared with the infinite magazine of their elements which has never been subject to change throughout the eternities, that they may be regarded as but the calculi resulting from the merest nodules of local and temporary inflammation — imperceptible to the health of the infinite corpus.

Thus I admit, with the pure dynamist, that the material universe, or successive material universes (if such a solecism is pardonable), as manifestations of matter and motion, are concatenated with time, are born, run their course, and fade away, as do the clouds of air. But the infinite reservoir of power wherein they occur as disturbances remains. What can cause these manifestations of power—these droopings of energy, with their complicated results? This is beyond our finite ken; but it is certain that the mere running through of its course of a finite evolution does not end the eternal, the infinite, and absolute. Nor can the mind be restricted to such a conception by any argument about the limitation of its faculties.

THE LEGAL STATUS OF SERVANT-GIRLS.

By OLIVER E. LYMAN.

SHORTLY after the Flood, as we are informed, Abram's wife turned her domestic, Hagar, out of the house on account of her arrogant conduct, which is perhaps the first authenticated instance on record of trouble between mistress and servant-girl. This sort of trouble, which began so early, still survives in forms so various and often so exasperating as to raise the impatient question whether the serving class is the only dark part of creation which improvement has failed to reach. The question is, no doubt, full of aggravation and discouragement, yet there has been improvement, but it has been of slow attainment, forming no exception to the great law of progressive social amelioration.

Social changes, it is to be remembered, especially of the alleviating and elevating kind, are always slow. We are beginning to talk about social evolution, and the new science of sociology which treats of it; but we have to take ages into account before we can realize any positive conception of advance. Much of the barbarism of early society clings tenaciously to the domestic relations, while the modification of human nature and the corresponding mitigation of social imperfections go on but very gradually, tardily, and partially.

A still further reason for the slowness of improvement in the present case arises from the peculiarity of the relations involved. In times of early violence, it is the weak that are subjugated and enslaved, and, as civilization advances, it is ever the lowest and most ignorant class of any society that falls into the condition of menial servitude. The feeblest, the least competent, the least provident, naturally sink to the bottom of the social scale, and become the helpers, the dependents, the drudges, and the servile appendages of the classes who have wealth, intelligence, and power. In domestic life these relations become organized with the abject class at the base of the social structure. Improving agencies will obviously not take effect alike upon the higher and lower elements. Many causes will operate powerfully to maintain separate interests, to favor the superior class, and to hinder their inferiors, so that servants will be the last to be reached by elevating agencies.

How slowly ameliorating changes in the domestic relations have proceeded, and how long their worst features have survived, are shown by the tenacity with which a vicious system of domestic servitude was clung to even in this country. Multitudes still remember the order of things in which half the country bought their servants from the auction-block. That primitive condition in which the menial was a merchantable chattel, with hardly more rights than a brute, continued down to these times, and has been got rid of only in the present generation. The slave system could have lasted as long as it did only in a form of society in which the menial class was low, degraded, and without influence. And that the slave system has in turn widely reacted to promote the social debasement of the working-class there can be no doubt. The slave system, of course, grew more and more anomalous as the sense of justice and humanity strengthened among the people; but we must not forget that slavery in this country was not destroyed by the moral reprobation of the community. It was defended as an historic and permanent order of society until it was incidentally terminated by revolution. It is now easy to execrate its atrocious forms, but we have by no means escaped from the baneful influence of many of its ideas. The idea of an abject menial class is still entertained as a part of the normal constitution of human society, while the associations of a degrading and but recently abandoned system are still potent for the debasement of those who continue in the relations of domestic service.

But, in spite of all this, the serving class, however disabled and degraded, will be found to have participated much in that general movement which we term the progress of society. Civilization may have been staggered by the "servant-girl problem," but it has not wholly broken down before it. The mistress can no longer kill her perverse domestic with impunity—although she may often think this is a step backward instead of forward. General tendencies have been at work which have put an end to the ancient order in this respect. In the early ages of domestic servitude, one of its incidents was the power of the master over the life of the servant. This prerogative has long since disappeared, though not because of the sixth commandment, or as a result of law reform, or the enactment of protective legislation. It was the culminating effect of a succession of natural causes, whose operation was gradual and extended over centuries. By captivity in time of war, or by the voluntary submission of the indigent, the prosperous and opulent became possessed of numerous servants, whom they chastised, sold, killed, and subjected to unlimited jurisdiction generally. In time the master possessed so many of these abject creatures that their numbers surpassed the accommodations of the household, and it became necessary to quarter them out upon the fields they cultivated. Here they lived in hamlets, and were called villagers, or villeins. Living apart from the master, it became less easy for him to keep a strict watch over their behavior, or to compel them to labor by chastisement. To incite them to work, gifts of money were made, and better results were obtained by making the pay proportionate to the results accomplished. Thus the master, using bribery instead of compulsion, and being removed from constant personal contact with his servants, had less occasion to become enraged at their short-comings, or to visit them with severe punishment. The exercise of dominion over life became less frequent, then ceased, and with a growing sense of justice the arbitrary power was forever lost, though it took centuries of the slow-working processes of evolution to accomplish this result. Potgresserus says that not till the twelfth century was the power lost.

But if progress has brought amelioration to the servile class and promises still more, it has brought also its disadvantages, some of which are the results of changed and improved relations. In the early ages masters and servants were more nearly alike in employments and manners of living than they are now. The acquirement of wealth and the luxurious habits which wealth introduced destroyed this degree of equality; the additional advantages inured to the benefit of the master alone; the servant remained indigent. The effect of social progress was thus to separate their lives as well as their interests. Servants constitute an isolated class. By an unwritten social law they are cut off from intimacy with their superiors, and consequently fail to reap the advantages which follow a community of interests with those above them. They fail to be leavened by the influences which act for the elevation of the community at large. This has operated to retard their progress and elevation, and produces aggravating effects which are more marked in our own republican country than in those countries where social gradations are more definitely established. Even in slavery there was a certain community of interest and responsibility on the part of the master, of which we see but little in the surviving forms of domestic servitude. This isolation drives servants to self-defense against the iron hand of control on the part of masters and mistresses, and results in a spirit of antagonism, leading to tacit conspiracy against those whom they regard as their enemies. Obligations sit lightly upon servants, and they habitually study to promote their own interests by unscrupulous arts and all kinds of dishonest practices. This may be deplored, but we may well ask, What are the servants to do? They are a disintegrated as well as an isolated class, and can gain but imperfectly the benefits which arise from combination. Equality is the universal theory; why, then, should they not demand increasing privileges, and rebel against the circumstances that keep them down?

But slow as has been the improvement of this class, and notwithstanding their humble social condition, and although they are too frequently regarded as a lower race of beings, with no rights except to obey, yet they have reached a stage of progress that entitles them to the protection of law, to which they are amenable also like all other people. The servant-girl has a legal status just as much as her mistress, and rights which ought to be held sacred, and, if they were so regarded, one important step toward the amelioration of the relations of lady and servant would be taken.

The relation of mistress or master, as the case may be, and servant is based upon *contract* only, and the two parties to the contract are upon an equal footing so far as rights are concerned. They differ only in what they agree to do—one is to work, and the other to pay—and thereon hang all the law and the prophets. It naturally follows that physical punishment can not lawfully be administered to a domestic. As Chancellor Kent said, "that is not an incident of the contract of hiring." It is hardly necessary to enlarge upon this right of servants, as the physical punishment of a domestic is rarely, if ever, heard of.

In the case of slavery, where the servant was owned, it was assumed to be for the interest of the master to provide medical attendance in time of sickness, but the free servant has no such claim. If a servant-girl falls sick, the mistress is not legally compelled to take steps to restore her to health. According to both Chancellor Kent and Mr. Story, the party hiring is not bound to provide a servant with medical attendance or medicines in case of sickness.* If a gentleman at the servant's request sends for a physician, he is not liable to pay the doctor's bill unless he omits to make known who requests the services, or unless he exceeds his authority, or expressly or impliedly engages to be answerable, either by directly promising to pay for them, if rendered, or by doing or saying something which justifies the doctor in supposing that he engages to pay him.†

But if the gentleman has hired a doctor, and given him to understand that he will pay him, he is bound to pay what the services are reasonably worth; he can, however, at any time give him notice that he will not be liable for further services.‡ If he calls the doctor in to attend the servant without the servant's request or consent, he must foot the bill; it being considered merely a generous act on his part.# A lady, too, under the same circumstances becomes similarly liable—provided she never had a husband or has buried him. If she is still

* 2 Kent, 298; 2 Story on Contr., § 1,298.

† 41 How. Pr. (N. Y.), 370.

‡ 1 Bosw., 441.

2 Story on Contr., § 1,297.

fettered by one, there seems to be some doubt as to whether she can make a valid contract that will bind anybody at all to pay the doctor. The law is not well settled. It may be said, however, generally, that she can not bind her husband, because the obligation of a husband to furnish medical attendance does not extend beyond his wife and own children, and he is under no obligations to provide it for a servant. And, as such attendance for a servant can hardly be called a necessary which the husband must provide the wife, she can not be considered as his agent for the employment of the doctor. So, too, she can not, as a rule, bind herself, because her identity is merged in that of her husband. She is not *sui juris*, and has no right to contract.* But, if she has separate property, the case may be different. In New York she can be held liable on her separate estate, if the intention to charge it is declared in the very contract, which is the foundation of the charges.† The rule everywhere, however, is not the same. There is a conspicuous lack of uniformity on the subject of married women's rights. Some day uniformity may be obtained. If those ladies who cry for the right of suffrage would shed half of their tears for a settlement of the laws pertaining to married women, they would accomplish results worth striving for. But to return to the doctor. The poor man, at present, had better take care when a married woman comes to employ him for her servant, or he may be "left out in the cold."

Although not bound to furnish medical attendance and medicines, it seems the party hiring is bound to furnish proper food, and to support the servant during her sickness or disability, so long as she remains in his or her employ.‡

Another right which a servant-girl has, is a right to the enjoyment of a good character—provided she has one—and the law presumes she has it until the contrary appear.# There is, unfortunately, a tendency on the part of a great many people to speak too freely, too thoughtlessly, and even maliciously, of the characters of others. The more marked the inferiority in social position of the person talked about, the greater the freedom with which the unbridled tongue wags; and just in proportion as the maligned person's station in life is lowlier, the injury done is the more irreparable. So it frequently happens that the character of one who has lived in a menial relation to us is spoken slightingly of, in a manner not justified by the facts. Thoughtlessness of the consequences of idle words, revenge for some act of the servant, or some other motive, may be at the bottom of it, but they afford no justification. The law protects her—or will, if she has cash enough to invoke its protection, or can persuade a lawyer to take her case on speculation. If, however, the communication is made by a person acting honestly and without actual malice, then, even though it be

* Schouler on Hus. and Wife, § 123.

† 22 N. Y., 450.

‡ 2 Story on Contr., §§ 1,297, 1,298.

Starkie on Libel and S., p. 19.

defamatory, the law protects the one making it. Servants bear such a peculiar relation to society that it is deemed necessary, for the common protection and well-being of its members, that honest and proper communications in regard to servants should be freely made, and that those called upon to make such communications should not be hampered by the apprehension of vexatious litigation. The good of the many is not to be sacrificed to save the few from injury. We see the same principle of protection in regard to communications made respecting the solvency of traders, the skill of professional practitioners, the trustworthiness of persons in confidential positions. The welfare of society demands that they be made freely, faithfully, and truly, and to give a servant a good character that is undeserved is a grievous offense.

On the other hand, one who designedly gives a bad character not deserved, under the pretense of discharging some duty to herself or to society, offends against justice and humanity, and the law throws no protecting cloak around her words. On one occasion a gentleman unasked wrote a letter in regard to a servant's character to another party, with the result of injury to the servant. The man was sued, and the jury found that he had acted maliciously, and rendered a verdict against him. The judge remarked: "I do not mean to say that, in order to make libelous matter (written by a master) privileged, it is essential that the party who makes the communication should be put into action in consequence of a third party's putting questions to him. I am of opinion he may (when he thinks that another is about to take into his service one whom he knows ought not to be taken) set himself in motion and do some act to induce that other to seek information from and put questions to him. The answers to such questions, given *bona fide* with the intention of communicating such facts as the other party ought to know, will, although they contain slanderous matter, come within the scope of a privileged communication. But in such a case it will be a question for the jury whether the defendant has acted *bona fide*, intending honestly to discharge a duty, or whether he has acted maliciously, intending to do an injury to the servant." *

In another case, a person told a servant girl's mistress that the girl was irregular in her conduct. The result was, she lost her place, and sued her defamer. The judge remarked: "If a neighbor make inquiry of another respecting his own servants, that other may state what he believes to be true; but the case is different where the statement is a voluntary act; yet, even in this case, the jury is to consider whether the words were dictated by a sense of the duty which one neighbor owes to another." †

Voluntary communications are looked upon askance. Stronger evidence is necessary to show that they were made in good faith than when the statements are made in response to inquiry.‡ And if a lady

* 8 B. and C., 578. † 1 Car. and Mar., 104. ‡ 8 B. and C., 578.

unasked displays a forward and officious zeal in giving a character prejudicial to a former servant, it will be a material guide to the jury in ascertaining the real motive.* The mere fact, however, that a communication is voluntarily made does not of necessity render it unprivileged, and, if the publication is warranted by an occasion apparently beneficial and honest, and there is no malice, it is not actionable.† If, for instance, a lady who has given a servant a good character finds that she was not justified in so doing, it is her right and it becomes her duty to communicate the facts to the person to whom the other communication was made, in order to prevent that person's being misled by the previous recommendation, and such a communication is privileged.‡ So, too, if a person to whom a servant has been recommended finds out that the character given was not justified by the servant's actions, and informs the lady who recommended her of the fact, and cautions her against giving recommendations for morality or honesty, this is, in the absence of malice, a privileged communication.# Where a lady gives a character in response to an inquiry, she will not be presumed to have been actuated by malice.‖ Even if what she says is untrue, she can not be successfully sued, unless the servant can prove that she spoke maliciously, and knew that what she said was untrue and injurious.^ And she need not prove the truth of her statement unless it is plain that she was actuated by malicious motives. If under such circumstances a *prima facie* case of falsehood be made out, she will be bound to show that the assertions were made under a belief in their truth.◊ A lady once had a young woman in her employ, who was afterward dismissed. Having a chance to make another engagement, she referred to her former mistress, who wrote to the person making inquiry: "I parted with her on account of her incompetency, and not being lady-like nor good-tempered. P. S.—May I trouble you to tell her that, this being the third time I have been referred to, I beg to decline any more applications?" The result could have been foreseen. The girl lost the engagement. Stung by the letter, she sued the writer, and general evidence was given of her competency, lady-like manners, and good temper, and that, in reply to the two previous applications which were made before her dismissal, the writer had recommended her. It did not appear in evidence why she was dismissed. The judge told the jury that they must decide whether there was sufficient proof that the defendant, in writing the letter, had been influenced by some improper feeling toward the plaintiff to make a false statement knowingly. They found that there was, and the plaintiff got a verdict.

On another occasion a man was asked about the character of a servant who had been in his employ, and he replied that she was dishonest. Of course, she lost the prospective engagement. She sued.

* Starkie, 344. † Starkie, 344. ‡ 30 N. Y., 20. # 1 F. and F., 24.
‖ Burr, 2425. ^ 3 Q. B., 11. ◊ 3 Q. B., 5; 109 Mass., 193.

It appeared from the evidence that the charge of stealing was not made until after she had left the defendant's service; that he had told her he would say nothing about it if she would resume her employment at his house, and that he afterward said to her that, if she would admit the theft, he would give her a character. The jury concluded that he was not acting *bona fide* in the reply he gave to the inquiry as to the girl's character, and gave her a verdict.*

In making a damaging statement to an inquiring person about a domestic, it is perhaps kinder to her to see that no one is present but the one interested in the inquiry. It may also turn out to be the safer course to pursue. It is true that such caution is not absolutely essential for the protection of the communication, but, if an opportunity is sought for making a charge before third persons when it might have been made in private, it affords strong evidence of a malicious intention, and thus deprives it of that immunity which the law allows to such a statement when made honestly; and, too, the fact that a third person is present is a circumstance which, taken in connection with others, such as the style and character of the language used, would have weight with a jury in determining whether the person making the statement had acted in good faith or had been influenced by malice.† The same thing may be said of an accusation made to a servant in the presence of another. It is a question for the jury. If it is made at such a time, on such an occasion, and under such circumstances that the inference of malice *prima facie* arising from the accusation is rebutted, the burden of showing that it was actuated by malice or ill-will rests upon the servant. It must, for instance, be made in good faith and for a justifiable purpose, in the discharge of a duty, public or private, legal or moral, or in the prosecution of one's own rights and interests, and without any design to defame the person to whom it relates, even though it is all untrue.‡ Thus, if a lady is about to discharge a servant, and calls in a third person to hear the reason therefor, and states the reason in that person's presence, the courts have held that such a communication made with honesty of purpose is privileged.# It has been held, however, in Massachusetts, that a false charge made before a third person is libelous.‖ If the statement is made in answer to inquiries, it must be to some person who has an interest in the inquiry, and not as mere matter of gossip.△ So, where a gentleman, having dismissed his servant for dishonesty, refused to give him a character, alleging to those who applied that he had dismissed him from his service for dishonesty, and the servant's brother afterward inquired of the master why he had so treated the servant, and was thus keeping him out of a situation, the gentleman replied, "He has robbed me, and I believe for years past."

* 16 C. B. N. S., 829. † 109 Mass., 193. ‡ 3 How. (U. S.), 266.
\# 16 Q. B., 322. ‖ 109 Mass., 193. △ 1 C. M. and R., 181.

Only one instance of robbery had been charged or proved, but it was held, nevertheless, that the answer to the brother was privileged.*

It seems, too, that it is within the scope of privileged communications to honestly protect one's interest by informing servants of the dishonesty of a fellow-servant. A man, having dismissed his servant, afterward remarked to two other servants: "I discharged that man for robbing me; he is a thief, and if ever you speak to him again or have anything to do with him I shall consider you as bad as him, and shall discharge you." This was held on a subsequent trial to be a privileged communication.

Let us now look at another right. Servants have well-defined rights in regard to wages. If they perform their part of the contract, they are entitled to a performance on the part of the party of the first part, to wit, the party hiring. Just what the servant has to do has been succinctly stated by Mr. Story: "A servant," says he, "is bound to obey all the just and reasonable commands of his master, to be careful and faithful as to all property committed to his charge, to do with diligence and care his proper and appointed work, and to behave with decency and in a manner consistent with his station as servant. . . . But the command must be just and reasonable, and within the fair scope of his employment." †

The right to the wages is not affected by the fact that there is nothing for her to do, if she is on hand and holds herself ready to serve.‡ The hiring being an accomplished fact, and the time of service begun, the right to wages exists. If there is nothing to do, so much the luckier for the servant. As a matter of fact, however, it may be safely said that such an easy state of affairs seldom occurs in the experience of most domestics.

The right to wages is unaffected also by damage done by the servant. For instance, if she injure articles or lose them in the course of the service, the party hiring can not without a specific agreement to such effect, deduct from the servant's wages their value, but must bring her cross-action against the servant for compensation.# So that, if a lady deducts for some such cause a portion of her cook's wages, the cook would have a perfect right to sue for the sum deducted. Inasmuch, however, as the party hiring can bring a cross-action, or, as in New York practice, set up a counter-claim in the cook's action, for the lost articles, the cook's net recovery would be *nil.* In other words, the legal and illegal ways of settling for the damaged or lost articles end in similar results. "It is six of one and half a dozen of the other." As a matter of practice and advisability, the illegal method of deduction, although it overrides the servant's rights, is better for her, as it saves her the expense of a lawsuit merely for a principle. The wise

* 16 Q. B., 322. † 2 Story on Contr., § 1,304. ‡ 32 Barb., 564.

\# 2 Story on Contr., § 1,297.

cook will not grumble at it. She, if anybody, ought to know that the frying-pan is better than the fire.

Nor can the party hiring deduct from the servant's wages any sum paid a physician called in by the hirer for the servant without the request or consent of the latter, nor in this case can a cross-action be brought for such sum, as the act is considered as merely one of generosity.*

If a servant hired for a specific time is wrongfully discharged before the expiration of the time for which she was hired, she can sue the party hiring for a breach of contract. She can bring an action either to recover for the services that she has actually rendered or for damages for the breach, in which latter case she can recover any amount already due her for services, and also compensation for damages sustained by the wrongful dismissal.† She can not wait, however, until the expiration of the period for which she was hired, and then sue for the whole wages on the ground of a constructive service.† It is obligatory upon her to diligently try to find another place. She must make reasonable exertions to diminish the damages. This is an *active duty* which the law wisely imposes. "Public interest and sound morality accord with the law in demanding this, and if the injured party through negligence or willfulness allows the damages to be unnecessarily enhanced, the increased loss falls upon him, and he can recover nothing for damages which by reasonable diligence on his part could have been prevented." ‡ If the servant has been unable to find employment, and has been forced into involuntary idleness by circumstances, her damages will be an amount equal to the whole compensation agreed upon. This was held in a case where the action did not happen to be brought until the time of hiring had expired.# In another case where a servant who had been hired for two months was discharged without cause at the end of five days, it was held that the servant was entitled to recover the wages for the whole two months, although there had been so few days' service.‖

If, now, on the other hand, the servant hired for a specific time is justly dismissed, or without reasonable cause leaves the service, what are her rights in regard to wages? Chancellor Kent says that in such case she loses her right to wages for the period she served.△ This is, undoubtedly, the rule where the full performance of the contract is a condition precedent to the right to wages, and through the servant's fault fulfillment becomes out of the question. Common sense and strict justice, however, lead to a different rule where the fulfillment of the contract is prevented or rendered impossible by the sickness or death of the servant. The law makes a distinction between the willful or negligent violation of a contract and where its fulfillment is prevented by the act of God. "In the one case, the application of

* 2 Story on Contr., § 1,297. † 4 Daly, 401. ‡ 28 New York, 76.
# 1 E. D. Smith, 70. ‖ 26 How. Pr., 528. △ 2 Kent, p. 292.

the rule operates as a punishment to persons wantonly guilty of the breach, and tends to preserve the contract inviolable. In the other case, its exception is calculated to protect the right of the unfortunate and honest man who is providentially and without fault on his part prevented from a full performance."* In general, the contract is subject to the implied condition of health and strength, and sickness will excuse a servant from liability, and justify her in rescinding the agreement.†

Such are some of the rules regarding the rights to wages of servants who are hired for a specific time. With those who are not hired for any particular time, as is the case with the majority of domestic servants, the case is different. The servant is considered as hired with reference to the general understanding that she shall be entitled to her wages for the time she serves, and either party, in the absence of any agreement to the contrary, may determine the service at any time.‡ The question most likely to arise on such termination is whether any notice must be given by the party terminating the service. In England, a month's notice is customary, and, if it is the hirer who ends the hiring, he can give a month's wages instead of the notice. If the dismissal is for misconduct, however, the servant is not entitled to the month's wages.# The English rule has not been incorporated in the law of this country. As was stated by Chancellor Kent, there is no distinction between menial and other servants. Whether notice is to be given depends upon the contract between the parties, or, if that is silent on the subject, it depends upon the custom of the particular place. Where there is an express contract upon the subject, it is binding, and must be observed, except in case of the disobedience of the servant, or under some other such circumstances. If the parties have not seen fit to take the subject of notice into consideration, no notice is required unless a well-established custom to give notice exists.‖

Before closing the discussion of the right to wages, mention should be made of an exception to the rule that the servant who performs faithfully her contract without breach is entitled to wages. The exception is that of persons whom the law deems unable to contract. Take the case of a married woman, for example. Where the common law still controls the relation of husband and wife, all wages the wife earns belong absolutely to him, and any promise made to pay her is considered as a promise made to him. And the common-law rule prevails except where it has been modified or changed by statute. In New York State, before 1860, a married woman who contracted for her personal services with the knowledge and consent of her husband, and was promised by the party hiring what her services were reasonably worth, acquired no title to her earnings in her own right.^ It

* 20 N. Y., 197. † 2 Story on Contr., § 1,303. ‡ Shars. Black., 426, n.
\# Cooley's Black., p. 129, n. ‖ Shars. Black., 420, n. ^ 42 Barb., 66.

was hard upon a poor wife, and the Legislature gallantly enlarged the rights of married women, so as to enable them to contract for their services, and receive and keep the pay for them for their sole and separate use, and to invest the same.*

Then take the case of minor servants. In general, a child's earnings belong to and are recoverable in the name of the parent. In the absence of an agreement, express or implied, that payment may be made to the child, the parent alone is entitled to the child's earnings.† The father, if living, can claim his child's wages; but, if he be dead, they belong to the widow so long as she remains unmarried.‡ The law puts upon her the support of the children, and so, if they go out to service while under age, gives her the right to their earnings, and to collect them. But if she marries again—presto!—her legal capacity is gone. She is no longer herself, but has merged her identity in another, and she can no longer control the property or earnings of her children.#

If in general there is an express or implied agreement that the child may receive the wages, that agreement supersedes the common-law rule. For instance, if a minor makes a contract for her services on her own account, and the father knows of it and makes no objection, there is an implied assent that she shall have her own earnings.‖ If, again, the parent resides in the same place, and neither receives nor claims any wages for the daughter's services for a long period, the inference would be strong that he or she intended that the daughter should receive her own earnings. Or, if the parent is absent for several years, and leaves the child to shift for itself, the presumption is that there was an intention to emancipate the child.^ In New York State the Legislature has taken a hand in this matter, and provided that payment of wages to a minor in service shall be valid unless the parents or guardians of such child notify the party employing the minor within thirty days after the service begins that they claim the child's wages.◊ And, under any circumstances, if it appears that the child at service has no parent or guardian entitled to her wages, the mistress must pay them to the servant.‡

Such are some of the rights of those who serve us. It would be a difficult task in the limits of a magazine article to treat of all their rights. Being human beings, and performing their lowly duties by contract only, the law clothes them with rights similar to those possessed by other persons, who are not compelled to undertake what we call menial work. Their property rights, for instance, are as sacred as those of princes. To steal a dollar from a cook is as wrong as to break open the safe of a banker. Their rights of life and limb also are just as inviolable as those of their employers. To kill a waitress is murder as well as when a queen is put to death violently. To chew up the

* L. 1860. † 5 Wend., 204. ‡ 5 Lans., 339. # 5 Barb., 122.
‖ 10 Barb., 300. ^ 8 Cow., 84. ◊ L. 1850. ‡ 29 Barb., 160.

thumb of a chamber-maid is mayhem just as surely as if it were the thumb of the President.

And so we might go on enumerating their rights in general, but the purpose of this article has been attained—to point out some of the rights of servants more or less peculiar to their calling in life, in the hope that a due recognition of them by those whom fortune has placed on a higher social pedestal will contribute a little to mitigate the worst evil of housekeeping. That it will eradicate the evil, or even be a panacea for half the attendant woes, is not for a moment claimed or expected. There are too many other independent elements at work to keep up the evil. But as each single drop of water falling on the stone helps to wear it away, so the observance of one form of relief will do its little toward wearing away the trouble which began with Hagar, and will end—Heaven only knows when.

THE NEW YORK GEOLOGICAL SURVEY.*

By JAMES HALL, LL. D., State Geologist.

THE history of the Geological Survey of New York from 1835, when the Legislature passed a resolution requesting the Secretary of State to report a plan for a geological survey of the State, is very easily traced, through the public documents and published reports made since that period. The events preceding, and which led to that action of the Legislature, are, however, of great interest and importance, and would of themselves form a very interesting chapter in the history of scientific progress in the State of New York, and of the country at large.

The mineral resources of the State had been the subject of discussion and inquiry even during the period of the Revolution ; and, soon after the conclusion of peace, societies were formed for the purpose of continuing these investigations, but so little of scientific knowledge was at that time possessed that no systematic progress could be made in this direction. The gradual but constantly increasing interest in agriculture and the arts stimulated inquiry, and there were not wanting men of intelligence, wealth, and position to foster and encourage such investigations.

These indirect influences, which resulted in shaping public opinion and making a geological survey possible, were for many years quietly in operation ; and the Society for the Promotion of Agriculture, Arts, and Manufactures, afterward the Society for the Promotion of Useful Arts, instituted in the city of New York in 1791, laid the foundation of scientific inquiry in the State, and its transactions afforded the

* From advance sheets of "The Public Service of the State of New York."

means of communication between the more intelligent people of the State upon all subjects embraced in its title. Chancellor Robert R. Livingston was the president of this society from its formation till the time of his death, in 1813; and the first volume of the Transactions (1791 to 1799) contains no less than eighteen communications from his pen upon various subjects.

The Annual Address for 1813 was delivered before the Society for the Promotion of Useful Arts, at the Capitol, in Albany, by Dr. Theodoric Romeyn Beck. In the preface to this address he stated that his aim in composing the address had been a special one. "It was to exhibit at one view the mineral riches of the United States, with their various application to the arts, and to demonstrate the practicability of the increase of different manufactures, whose materials are derived from this source."

The most notable and important movement in the progress of scientific study began about 1817, when Professor Amos Eaton, after having prepared himself at Yale College with the best means and instruction then afforded, began his courses of scientific lectures at Williams College, which he afterward extended to the larger towns of New England and New York. In 1818, at the invitation of Governor De Witt Clinton, who was ever a most enlightened and liberal advocate of scientific progress, Professor Eaton gave a course of lectures before the New York Legislature, some of whose members had already been his pupils. At this time much interest was awakened in the subjects of geology and other departments of natural history throughout the State. Professor Eaton's lectures in Troy led to the organization of the Troy Lyceum of Natural History, which at that time could boast of possessing a more extensive collection of geological specimens than could be found in any other institution within the State of New York. In 1820 and 1821 Professor Eaton, with the assistance of Drs. T. Romeyn and Lewis C. Beck, under the patronage of Hon. Stephen Van Rensselaer, carried out an agricultural and geological survey of Rensselaer and Albany Counties. These surveys, reports of which were published, were intended to be made subservient to the interests of agriculture, and were spoken of in the "American Journal of Science" as being the most extensive and systematic efforts of the kind made up to that period. In 1822, under the patronage of Hon. Stephen Van Rensselaer, Mr. Eaton undertook a geological and agricultural survey of the district adjoining the Erie Canal. The report upon this work was published in 1824, in a volume of one hundred and sixty-three pages, with a geological profile extending from the Atlantic to Lake Erie, and a "profile of rocks crossing part of Massachusetts" (from Boston Harbor to Plainfield), by Rev. Edward Hitchcock, who also furnished a description of the rocks and minerals crossed by this profile. In 1824 General Van Rensselaer established the Rensselaer School in Troy, and its graduates became efficient aids in the dissemination of scientific knowledge and in the cultivation of those scientific tastes which pervaded all the better classes of communities for many years. Much had already been done, therefore, to prepare the way, and the public mind was fully awake to the interests and importance of a geological survey, when the Albany Institute, in 1834, memorialized the Legislature for some action in that direction.*

These memorials were referred to a committee of the Legislature, who recommended a resolution by which the Secretary of State was "requested to report to the Legislature at its next session the most expedient method of obtaining a complete geological survey of the State, which shall furnish a scientific and perfect account of its rocks, soils, and minerals, and of their localities; a list of all its mineralogical, botanical, and zoölogical productions, and provide for procuring and preserving specimens of the same; together with an estimate of the expenses which may attend the prosecution of the design, and of the cost of publication of an edition of three thousand copies of the report, drawings, and geological map of the results."

In pursuance of the request contained in this resolution, the Secretary of State, Hon. John A. Dix, presented a report at the following session of the Legislature, which contained much valuable information with reference to what had already been done toward developing the mineral resources of the State, giving a summary of our knowledge of the subject at that time, and discussing several questions of great interest; for example, the salt and salt-bearing formations, our mineral springs, and the probabilities of finding coal within the limits of the State. He also gave a statement of what had been done in other States, and of work in a similar direction elsewhere in progress or in contemplation.

Under their distinctive heads he discussed the botany and zoölogy of the State, and gave reasons why each one should receive due attention. Under the head of Zoölogy the subject was treated under the following subdivisions: Quadrupeds, Birds, Fishes, Testacea,† Zoöphytes, etc., and lastly the Insects.

The report concluded with the recommendation of a plan for the Geological Survey by a subdivision of the State into four districts,‡

* Senate Document No. 15, 1834.

† Under this head the Secretary of State said: "Our shells, whether of marine, lake, river, or land production, deserve a very critical examination, more especially as the fossil remains of this extensive tribe of animals, both of living and extinct species, are considered as affording the most certain criteria for determining the priority of existing geological formations in the order of time. There is no department of our natural history which, for scientific purposes, requires more careful investigation. Specimens should be preserved for systematic classification and arrangement; and it is by no means improbable that these collections, with the fossil specimens, which may be found imbedded in our rocks and soils, will be instrumental in showing the identity of formations here and in the Old World, which have hitherto been considered entirely different in their geological character."

‡ The First District consisted of the counties of Suffolk, Queens, Kings, Richmond,

which plan, with some modifications, was carried out in the final organization. This plan contemplated the employment of two geologists for each district, which was modified to the appointment of one geologist and an assistant for each district. One mineralogist was appointed for the entire State, and also one botanist and one zoölogist.

During the session of 1836 the Legislature passed "an act to provide for a Geological Survey of the State," authorizing and directing the Governor to employ a suitable number of competent persons, whose duty it shall be, under his direction, to make an accurate and complete geological survey of this State, which shall be accompanied with proper maps and diagrams, and furnish a full and scientific description of its rocks, soils, and minerals, and of its botanical and zoological productions, together with specimens of the same; which maps, diagrams, and specimens shall be deposited in the State Library; and similar specimens shall be deposited in such of the literary institutions of this State as the Secretary of State shall direct.*

The act further provided for an annual appropriation for defraying the expenses, and required the persons employed to make an annual report to the Legislature on or before the first day of February in each year, setting forth the progress made in the survey.

The magnitude and importance of the work were duly considered by Governor Marcy and his advisers,† and the appointments were made only after long deliberation, and extensive correspondence with the prominent scientific men of the country, and with the Governors of other States.

The appointments of the principal geologists were made as follows: Lieutenant W. W. Mather, a native of Connecticut, who had lately resigned from the United States Army, was assigned to the First Dis-

New York, Westchester, Rockland, Putnam, Dutchess, Orange, Sullivan, Delaware, Ulster, Greene, Columbia, Rensselaer, Albany, Schoharie, Schenectady, Saratoga, and Washington, containing an area of 12,263 square miles

The Second District consisted of the counties of Warren, Essex, Clinton, Franklin, Hamilton, and St. Lawrence, to which was afterward added the county of Jefferson, making 10,817 square miles.

The Third District comprised the counties of Montgomery, Herkimer, Oneida, Lewis, Jefferson (afterward added to the Second District), Oswego, Madison, Onondaga, Cayuga, Wayne, Ontario, Monroe, Orleans, Genesee, and Livingston, making, as reorganized, 11,468 square miles.

The Fourth District consisted of the counties of Otsego, Chenango, Broome, Tioga, Cortland, Tompkins, Seneca, Yates, Steuben, Allegany, Cattaraugus, Chautauqua, Erie and Niagara, embracing an area of 11,594 square miles.

The Third and Fourth Districts were afterward reorganized, making all the counties to the west of Cayuga Lake, and a line drawn north and south from its two extremities, the Fourth District, which contained 11,060 square miles.

* Laws of fifty-ninth session, chapter 142.

† Among these gentlemen were Hon. John A. Dix, Secretary of State, Hon. Stephen Van Rensselaer, Dr. T. Romeyn Beck, Professor Amos Eaton, and Edwin Croswell, Esq., who had frequent meetings, which were continued at intervals through several months.

trict; Professor Ebenezer Emmons, of Williams College, was assigned to the Second District; Mr. T. A. Conrad, of Philadelphia, was assigned to the Third District; and Mr. Lardner Vanuxem, of Bristol, Pennsylvania, to the Fourth District.*

The mineralogical department was assigned to Dr. Lewis C. Beck, a native of Albany, but at that time a Professor in Rutgers College, New Jersey. Dr. John Torrey, of New York city, was commissioned as State Botanist, and Dr. James E. De Kay, of Long Island, as State Zoölogist.

The assistants in the geological department commissioned by the Governor were, Caleb Briggs in the First Geological District, James Hall in the Second, George W. Boyd in the Third, and James Eights in the Fourth District.

The instructions given to these officers were essentially the same as recommended in the report of the Secretary of State. Each of the geologists was required to collect, in his own district, eight suites of rock specimens, but no conditions of this kind were imposed upon the mineralogist, botanist, or zoölogist. A special draughtsman was appointed for the zoölogical department and also for the botanical department. The geologists were each allowed a small sum ($300) annually to pay for drawings of sections, maps, etc., which might be required for the illustration of their reports.

This, in brief, was the organization of the Geological Survey at its commencement. At the end of the first year, it became evident to the geologists that the relations of the rock formations, the age and order of superposition, among the then unknown, or very imperfectly understood, stratified deposits, could only be determined on paleontological evidence. They therefore unanimously recommended to the Governor that some competent person be appointed to devote himself to that department. To this position Mr. Conrad was assigned, thus leaving a vacancy in the Third Geological District, which, after a reorganization of its boundaries, as before explained, was assigned to the charge of Mr. Vanuxem, and Mr. Hall was appointed to the Fourth District.

As had been suggested in the report of the Secretary of State, the scientific staff assembled each year, and sometimes twice a year, in spring and in autumn, at the Capitol, to compare notes and observations, to agree upon methods of work, and to receive suggestions from the Governor. These meetings became more important and even essential to the geologists, since they soon found themselves dealing

* It will be seen that neither of the principal geologists was a native or resident of the State of New York, though Lieutenant Mather had previously been instructor in the Natural Sciences in the Military Academy at West Point. Nor should it be forgotten that no inquiry was ever made regarding the political opinions of these gentlemen, and it proved that, of the seven principals of departments thus appointed, six were in political opposition to Governor Marcy.

with a series of rocks which, up to that time, had received no full elucidation in any country; hence the necessity of comparing observations and views, with the purpose of agreeing upon some common terms of designation became apparent, and very soon, imperative. The comparison of observations and interchange of views led to the opening of correspondence, by a formal resolution of the New York Board, with other geologists, especially with those engaged in State surveys, of which several were then in progress. This correspondence led to an agreement for a meeting of geologists in Philadelphia in the spring of 1840, and this assemblage of less than a score of persons led to the organization of the American Association of Geologists, which, at a later period, on the occasion of its third meeting, added the term Naturalists; and finally, by expanding its title, it became the American Association for the Advancement of Science. It is due to the State of New York that these facts appear in this connection, and it is but fair to state that her geologists have contributed largely to the subjects of discussion and to the array of new facts which have been brought before the scientific world through the agency of this organization.

During the few years of field work, the New York geologists had harmonized the conflicting views before entertained regarding the relations of the geology of the eastern and western parts of the State; they had traced the boundaries of the successive geological formations; had shown the extent and limits of the iron-bearing strata, and had rectified the erroneous views which had been held till some time after the commencement of the survey, regarding the boundaries and distribution of the salt-bearing formation of the State. They had, also, shown the limits of the granitic formations, and their associated mineral products; the thickness and extent of all the limestone, sandstone, and shale formations of the State, and had definitely settled the relations of the rocks of New York to the coal-measures of Pennsylvania and the geological formations of the Western States.

Their labors had in a great degree quieted the feverish anxiety regarding the discovery of coal within the limits of New York, for which frequent explorations had been made in the black slates of the Hudson River Valley and elsewhere, involving the expenditure of much money and loss of time.* A rational idea of the general geological structure, and the relations of the geological formations of the State, had been acquired by the intelligent population, through the annual reports of the survey, which presented the results of each season's work in the field.

* Professor Mather has estimated, from what he regarded as reliable data, that the fruitless coal-mining enterprises which had been undertaken in the Hudson Valley alone, during the fifty years preceding 1840, had cost more than a quarter of a million of dollars. The sums thus expended in other parts of the State, though doubtless much less, must, nevertheless, have been very large.

During these years the New York geologists had accumulated a vast amount of material and of facts regarding the geological formations within the State, proving conclusively that they could not be parallelized with any of the described and well-determined formations of Europe. The Silurian system of Murchison, as described and illustrated in the "Edinburgh Review," in 1838, and as finally published in 1839, although covering a portion of similar ground, was not broad enough to meet the requirements of the geology of New York. Thus failing to find the means of comparison and identification, the term "New York System" was proposed, to embrace the sedimentary formations from the Potsdam sandstone to the base of the carboniferous system; or, as the formations were developed in New York and southerly into Pennsylvania, the upward extension of this term reached to the base of the coal-measures.* This term, "New York System," includes the formations ordinarily embraced in the names Cambrian, Silurian, and Devonian of England and the Continent of Europe. The geological series in New York is so complete that the succession leaves no lines or breaks for the establishment of "systems," the whole being but a single system; and had the older rocks of the globe been first studied in this State, no such terms or subdivisions would ever have found their way into geological nomenclature. The strongest line of demarkation, however, or the most marked interruption of continuity in the succession, occurs at the termination of the Hudson River group, where a great conglomerate or a heavy-bedded and well-marked sandstone terminates the physical and biological conditions of the preceding period. This break in the continuity, which is the proposed limit of the Cambrian system, is, however, only of local importance.

Since there was no possibility of identifying the individual rocks and groups of strata with those of Europe, as described, the New York geologists were compelled to give names to the different members of the series; and since the sandstones, limestones, slates, and shales are so similar in different and successive groups, it was impossible to give descriptive names which would discriminate the one from the other. Therefore, local names were proposed and adopted, as, for example: Potsdam sandstone, Trenton limestone, Niagara limestone, and Niagara shale (the two latter, with subordinate beds, making the Niagara group), the Medina sandstone, the Onondaga salt group,† the Hamilton, Portage, and Chemung groups, thus giving typical localities of the rock instead of descriptive names. This method or system

* In Southern New York and adjacent Pennsylvania the highest member of the New York system is the Upper Catskill gray sandstone and conglomerate. The rocks pertaining to the coal-measures supervene, without the presence of the great carboniferous limestone and associated strata of this age in the States of the West and bordering the Mississippi Valley.

† The term "Onondaga salt group" was regarded as objectionable on account of its length, and the term Salina was not adopted simply because the rocks of the formation or group are not visible nor accessible in the town of Salina.

of nomenclature leaves no possibility of mistake or confusion which might arise from a different appreciation of descriptive terms. The typical locality always remains for study, comparison, and reference, and there need be no difference of opinion or discussion as to what was intended by the use of any one of the terms. The progress of geological science in the country is greatly indebted to this system of nomenclature, and to the absolute working out of the succession of the groups, and the members of the same, to which this system of nomenclature has been applied.

At the final meeting of the Geological Board the adoption of the term "New York System" was considered imperative, because of the impossibility of harmonizing the formations here known with those of Europe. In the adoption of the names of rocks and groups—the nomenclature as now known—there was scarcely a dissenting voice, and the names as then adopted were published in the final reports, and have become the nomenclature of the science in America.

As the field-work of the survey approached completion, the question of publication became a matter of deep interest to every one connected with the work. The incumbents in each one of the departments were desirous of publishing their work in octavo, that the results of the survey might appear in a convenient form, and become hand-books for students in science. This plan, however, was overruled by Governor Seward and his advisers, who considered it due to the dignity and importance of the State of New York that the volumes should be published in quarto form, especially as they were to be presented to other States and foreign governments as emblematical of the greatness of the State. Governor Seward himself wrote an introduction of nearly two hundred pages to the first published volume of the work (Zoölogy—Mammalia) in 1842. This volume was followed by others in the same year. The geological reports were all completed in 1843, and the last volume of Zoölogy, that upon the birds of the State, by Dr. De Kay, was published in 1844.*

In 1842 Mr. Conrad resigned his position as paleontologist of the survey without communicating any report to the Governor, and the four geologists who had expected to avail themselves of the results of his investigations were left to their own resources. In this state of affairs each one of the geologists illustrated his own report, as best he could, by figures of characteristic fossils of the rocks and groups which he had studied in his own district. By this means a very considerable number of the more common and characteristic fossils were illustrated in woodcuts, which were printed in the text, thus giving authentic guides for the determination of all the more important members of the series.

* The work thus completed embraced the following subjects: botany, two quarto volumes; zoölogy, five quarto volumes; mineralogy, one quarto volume; geology, four quarto volumes, of each and all of which three thousand copies were published.

The incompleteness of the contemplated Natural History of the State was recognized by the Governor and Legislature, and it was also claimed that agricultural interests had not been sufficiently considered in the work already published. It was, therefore, determined that the department of paleontology should be re-established, and that of agriculture be added to the plan of the work. Under the latter title Dr. Emmons published five volumes; the first being devoted to the general relations of the topography and geology of the State to its agriculture and agricultural products; the second, to the chemical analysis of the soils and agricultural products, with extended observations upon the temperature of the air, soil, etc.; the third and fourth (text and plates), to the description and illustration of the cultivated fruits of the State; and the fifth, to insects, chiefly those injurious to vegetation.*

The paleontology was committed to Mr. James Hall, who entered upon the work in 1844.† Volumes one and two had been substantially completed and the third considerably advanced, when, in 1850, further appropriations were withheld and the work virtually suspended. In 1855, through the influence of the Hon. E. W. Leavenworth, Secretary of State, the work was revived and a plan for its completion proposed. A provision was also inserted that an appropriation from the State for the collection of fossils should be made annually for eight years. Through this means large collections were made and a great amount of new material added to that previously obtained, and this necessarily and unavoidably expanded the work much beyond what was originally contemplated, and beyond what could have been expected before such collections were made.

At the present time, five volumes of the Paleontology have been published, two of which were bound in two parts, making the entire number of seven bound volumes. These volumes contain about twenty-seven hundred pages of text and five hundred and sixteen plates. At the time of this writing the work has been virtually suspended for the past two years, with one hundred and seventy-five plates already lithographed and printed, and more than sixteen hundred pages of manuscript ready for the printer, besides drawings for more than one hundred and twenty-five plates.‡

* Many of the results obtained by the late Dr. Fitch, of Salem, New York, and by Dr. Harris, of Cambridge, are incorporated in this volume.

† The work was begun almost without collections of fossils of any kind, without a library for reference, without artists or any of the appliances or resources considered necessary in scientific investigation and illustration. It became necessary to create the department from the beginning. No appropriations of money were made by the State for the collection of fossils until 1856, and this burden of labor and expense bore heavily upon the author of the work.

‡ No printing has been done for three years (since 1879), and no lithographic work for about two years. The delays in the publication of the volumes during the past are not chargeable to the author. The work was virtually suspended from 1850 to 1856.

Up to the present time the entire publication of the Natural History of the State, exclusive of the Annual Reports of the Survey and thirty-five Annual Reports of the State Museum, may be enumerated as below:

Botany, in two volumes	bound	in	2	volumes.
Zoölogy	"	"	5	"
Mineralogy	"	"	1	"
Geology	"	"	4	"
Agriculture	"	"	5	"
Paleontology, five volumes	"	"	7	"
			24	volumes.

Of these twenty-four volumes, three thousand copies each have been published, making the entire number of seventy-two thousand quarto volumes, which have been published and distributed as the result of the Geological Survey of the State.

At the close of the field-work of the survey, the question of the disposition of the collections which had been made became a subject of much interest. It had been originally suggested that these might occupy a room in the State Library, or be arranged in some of the unused committee-rooms in the Capitol. The amount of material, however, was so great, and the importance of its proper arrangement so manifest, that the old State Hall, at that time about to be vacated, was appropriated for the purpose of a State Museum. At a later period (1857) the old building was demolished, and a more commodious one erected on the same site; and this is now filled to overflowing, and a large amount of collections remain unprovided for. In nearly all respects the survey has been carried out according to the original conception and plan. It has resulted in far larger and more interesting collections, and in far more interesting and valuable publications, than could ever have been anticipated by its original promoters. It has laid the foundations of geological science in our country, and made the State of New York the classic ground for the study of palæozoic geology.

The cost of the survey being computed in dollars, the value of the results is sometimes estimated by a similar standard; but the peo-

Great delay occurred in the completion of the plates of volume three after the text had been printed. The fourth volume was greatly delayed, both in the printing of the text and the lithography of the plates, owing to the enhanced price of all materials and labor during the war; and for the same reason very little progress was made with the fifth volume until a modification of the printing contract was made in 1871, which enabled the printer to go on with the work. Fully four years were lost on this account. The manuscript for volume five was, according to contract, deposited in the State Library in 1866, but after these years of delay it became necessary to revise and expand the same to include new material, which had been obtained and investigated during this interval. In the end, therefore, it became necessary to make two parts of this volume, one of which has already been published, and the other has been for three years ready for printing.

ple of the State of New York might with equal propriety measure the value of the common-school system by the commercial value of their school-houses and grounds. The absurdity would be equally as great in the one as in the other case. Like the system of public education, the results of the Geological Survey have penetrated into every school district and into every corner of the State; and these results are not to be measured by the figures representing dollars, but by the increased intelligence of the people, and the proud satisfaction that we have been able to lay broad and deep the foundations of geological science in the soil of a people whose motto is "Excelsior."

ORIGIN OF THE CALENDAR AND ASTROLOGY.

By Professor WILLIAM FOESTER,

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THE significance of the astronomical portion of the calendar is materially different at present from what it was in the earlier stages of its development. That this may be clearly understood, and the modern problem with which astronomy has to deal in the yearly construction of the calendar justly appreciated, let us examine the history of its origin.

The word "calendar" is derived from *calendium*, denoting the commencements of months, which, in the language of ancient Rome, were called *dies calendæ*, or simply *calendæ*; i. e., days on which "calling out" should occur, from "*calo*," *I call*. This "calling out" took place upon the reappearance of the small crescent after new moon, and at the present day remains the custom among those people who, as for instance the Turks, reckon time wholly from the recurring phases of the moon. This was loudly proclaimed from the roofs of public buildings by appointed priests or seers, who were required to seek for the moon's crescent in the evening sky either two days after new moon, or four or five days after the last appearance of its light in the morning sky; this, then, was established as the beginning of the month, the single days being reckoned by counting backward or forward from the night, or from the intermediate day of full moon. This method of reckoning time from the revolutions and phases of light of the moon has been long practiced in those countries in which the constant clearness of the heavens enables people to determine with considerable accuracy the first appearance of the moonlight, the so-called "new light," and, again, among those whose limited intercourse with other nations afforded no comparison of fixed standards. In

* "Popularische astronomische Mittheilungen." Berlin: Horrwitz & Gossmann. Translated by L. M. Muzzey, B. S.

countries, however, where continued clearness of the sky was not afforded, or where the necessity was urgently felt for a regular determination of future dates, the seers at length desired that they be permitted to calculate, upon the basis of the past determinations of the duration of the regular months, the recurrence of the phases of the moon for a certain time in advance, and therewith the regular succession of the months, and to publicly record the number and the method of counting the days of the single months. Thus, in place of the public proclamation from the house-tops of the observed appearances, the calendar now came into use, containing calculations of the "calling days."

Gradually, however, when after a length of time the new light of the moon failed to appear at the specified date, in consequence of the imperfection of the calendar's determination, the proclaiming was entirely abandoned, and the moon in the calendar became more the standard for reckoning time than the moon in the heavens. It was repeatedly sought to compensate for these variations by revision of the calendar; but the more accurate methods for computing time, which gradually came into general use, soon supplanted the lunar chronology, and the months retained in their duration simply an approximate relation to the lunar month of twenty-nine and a half days, and were finally apportioned as twelve nearly equal divisions of the year.

The solar year, as a great heat-period, naturally attracted the observation of men at an early time, and the knowledge of the recurrence of the same degree of warmth was early recognized as of great importance to the interests and progress of agriculture and navigation. As a period, however, for the reckoning of the days the year was too long, and it was only with the advance of science that it gradually attained to chronological significance, namely, as a large and suitable unit of time for the division into months and days. The recurrence of similar phases of the year and evolution of heat were next associated each time with the appearance of certain celestial phenomena, in like manner as the commencement of the month with the reshining of the moon, and these observations were intrusted to individuals, who either proclaimed or published them. A common yearly calendar was thus prepared in advance, upon the basis of long and careful observations of the times of the recurrence of these phenomena, giving the days of certain months of each year on which they were to be seen, the changes of weather which would then take place, and these days were to form the reckoning points of time.

These phenomena in the heavens from which the data were derived were those positions of the sun in the sky, at certain intervals, relative to some fixed star or constellation, which could be most readily recognized with the naked eye; and, since the light of the sun far supersedes that of the brightest fixed star, these observations could be made only in the morning or at evening twilight, when it was noticed what bright star was visible near the horizon immediately before sunrise or after sunset. The apparent movement of the sun in the sky made itself manifest from the fact that the stars which were discernible in the western horizon shortly after sunset ceased to be visible after some days, the sun seeming to approach them, and that those observable in the eastern horizon shortly before sunrise gradually remained longer visible in the dawn, the sun appearing to recede from them.

In Egypt, for example, it was noticed that the overflowing of the Nile—which is the result of certain tolerably regular changes in the weather, caused by the position of the sun—always occurred on those days on which the bright light of Sirius was again visible in the morning twilight. In Greece it was likewise observed that those risings and settings of the Pleiades, of Orion, Arcturus, and others, which occurred in the morning or evening twilight, were related to certain yearly variations of heat, and to the directions of great atmospheric currents, and were, therefore, convenient guides in agriculture and navigation.

As the calendar advanced, however, in the predetermination of days and phenomena on which periods of human labor were dependent, the attention of the majority of men was diverted more and more from the direct observation of the moon, the sun, and stars, resting contented with what was stated in the calendar, so that even in the civilization of the present day an evening is accepted as clear if *moonshine* is set down in the almanac. The sun, moon, and stars, together with those other wandering bodies in the heavens, the planets, won a new significance through the origin of astrology, which advances in the following manner with the progress in calendar calculations:

The publication of arranged calendar matter and the constant improvement in the same were owing chiefly to the efforts of wise men, in early Greece, for instance, to the zealous labors of the priesthood at Delphi, who justly esteemed an established calendar a potent element of national unity and order, and as a means of security against the power and influence of those fostering secret teaching. Among other people, as the Romans, the selfish and ignorant priesthood deemed it for their interests to allow such determinations to remain in obscurity, or, on the ground of real or fictitious observations, to regulate the calendar as they desired. In fact, the influence of the seers and priests upon the people would be greatly lessened if the knowledge, which they had acquired of the times of revolution of heavenly bodies and the chronological periods dependent thereon, were to become the property of all; and this loss would be still more augmented, when the unavoidable inaccuracies of these public observations became after a time recognizable, rendering repeated changes in the calendar necessary, or when, in consequence of this, several systems of reckoning time strove for preference.

The difficulty lay chiefly in the fact that the light phases of the moon and the positions of the sun in the heavens do not recur in a full number of days, and that a solar year does not contain a full number of months; the various phases of the moon requiring a little more than $29\frac{1}{2}$ days, and the positions of the sun somewhat less than $365\frac{1}{4}$ days; thus making the solar year contain about 12 months and 11 days.

To illustrate: if months of 29 and 30 days be alternated, if 365 days be allotted to each solar year, and after 99 such months (equivalent to eight years), the counting of the months be made from the same date of the year, a tolerable agreement with celestial signs could, indeed, be attained, but after a number of years the date of the month would differ from that indicated by the moon, and with a greater lapse of time the accepted solar year would show a decided variation from the annual position of the sun and moon, and, in fact, from the yearly heating effects of the sun. An improvement could, indeed, be made if, in the alternation of months of 29 and 30 days, two months of 30 days each be allowed to succeed each other at intervals of 33 months; also, if each fourth solar year were to contain $365\frac{1}{4}$ days instead of 365, and if, finally, once in nineteen years, the so-called golden cycle, the reckoning of the lunar months began with the same date of the sun; but a uniform and perfect coincidence of these cycles of days, months, and years would also, in this manner, be unattainable. In short, the problem was purely an arithmetical one, especially difficult so long as it was sought to make the minor divisions of the year agree with the appearances of the moon, and it is, accordingly, no matter of wonder that many fruitless attempts at improvement were made before a judicious and adequate method was discovered. The founder of Islam clearly recognized the danger which the unsuccessful attempts to construct a calendar for future time engendered for the authority of the leaders in that religion, and hence arose the fear that the unavoidable conflict of different calendars would promote the formation of religious sects. Mohammed forbade, therefore, the establishment of any connection of the lunar month with the solar year, and ordered all calculations to be made from the observation and proclamations of the new light of the moon. While the peculiar difficulties of the chronological problems had afforded, on the one hand, advance in the observation and understanding of the movements of the heavenly bodies, and, on the other, had brought calculations of time into discredit, these astronomical inquiries produced still other important results at an early date, as in Babylon, many centuries before the conquest of Alexander the Great. These results, extending beyond the limits of chronology, secured to astronomers a mighty influence over the minds of the people, notwithstanding the repeated inaccuracies occurring in the calendar. This was attained through the teachings of astrology.

The systematic and long-continued recording of the celestial phenomena had made known, among other things, the cycle of eighteen years, eleven days, in which the lunar eclipses repeat themselves in the same order, and in which there occurs also the possibility of the solar eclipses succeeding each other in nearly the same order. The prediction of eclipses, based upon a knowledge of these periods, and of phenomena which had no such regularity of occurrence as the fundamental chronological ones, and which seemed as frightful disturbances among the heavenly bodies, naturally produced a deep impression, which, in many cases, has been pictured to us, and therefore rendered the knowledge of the stars a peculiarly prophetic wisdom in the eyes of the people. Hence it followed that the development of the solar calendar and its connection with the position of the sun, relative to certain fixed stars and constellations, necessarily produced the conception of a particular influence of the stars upon the destinies of men.

The first appearance of a star in the morning twilight was considered as an indication of important earthly events, of wind and weather, of moisture and dryness, growth and harvest, and its simple position was held, in the popular belief, to be capable of exerting a great variety of influences.

Moreover, the advance made in the knowledge of the stars had also led to more careful investigation of the movements of those five bright stars which, like the sun and moon, changed their position in the heavens, two of them seeming, like companions, to connect themselves with the sun; so that these five planets which, on account of their movements among the stars, seemed nearer the earth than the stellar world, soon came to receive a share of the deification of the sun and moon.

They formed with the latter the sacred number of the seven heavenly powers. This number "seven" is supposed to have led to the division of the interval between two successive changes of the moon, forming the week of seven days. It was hence perfectly natural that the mythical names which the planets soon came to bear, and their positions in the heavens relative to one another and to important fixed stars specified in the calendar, should be regarded as pregnant with meaning, and especially so when the peculiar character of the planet itself, as illustrated in Mars by its striking red light, rendered its deification of increased significance.

Thus, the prediction of eclipses and of other celestial phenomena, as the only means of forecasting future events which had then been attained, the explanation in the calendar of the rising and setting of the stars and the mythical characterization of the planets, were all the fruit of the strong desire in men to lift the veil of the future and of a deep earnest reverence for the lights of heaven, which pursue their eternal and unchanging courses above all earthly mutability.

Another cause of the power which this mighty system of astrology continued to exert over the minds of people during so many centuries, and whose traces are still observable in greater or less degree, not only in the minds of the masses, but also in men of acute understanding, is suggested in the pithy remark of Kepler: "The failures of astrological predictions are soon forgotten, because they are of little consequence; their fulfillments are retained with the greatest tenacity; hence, the astrologer remains in veneration."

In fact, such teachings did not receive, at first, unhesitating acceptance; and it was not until individual chance successes were attained, that the belief in the positions of the stars as affecting human destiny found so deep root in inclined minds as to render the prophecies themselves instrumental in bringing to pass predicted events, so that for centuries no doubt to the contrary found popular recognition. When the first teachings of astrology thus founded by the priesthood, and more or less designed to promote its interests, became the possession of philosophers, as of the Greek astronomers of the Alexandrian school, they then gradually assumed a certain scientific character. The force which the moon exerts upon the waters of the earth, in causing the ebb and flow of the tides, was regarded by Ptolemy as chief scientific proof that other heavenly bodies besides the sun exercise a direct influence upon terrestrial life.

Moreover, it was held that the moon exerted a disturbing influence upon sleep, its monthly recurrence affecting the nervous system. On the basis, therefore, of these general predictions, it was then sought to determine the influence upon life and destiny which the various positions of the moon and planets among the constellations of the zodiac exerted, and to discover, partly by astronomical calculation, partly by tradition, what positions the planets had assumed at the time of the birth, as well of striking events in the lives, of distinguished men; or, in general, during the time of a series of important events.

A seeming uniformity in the casual coincidence of celestial phenomena with certain fortunate and unfortunate events was thus derived from this knowledge of the past, and formed the foundation of the methods for forecasting the future.

Naturally, this teaching had to embody a certain number of apparently verified prophecies, which were not derived from conclusions concerning the past, but were purely conceived, or which were associated with the mythical character of individual heavenly divinities.

Thus the planet Saturn, or Cronos, was universally regarded as destroying and harmful, as the powerful, all-consuming god of time whose name he bore; the planet Jupiter, on the contrary, indicated universal fortune, majesty, and beauty.

The planet Mars represented by its omens the dangerous and violent; Venus the mild and pleasant; Mercury the ambiguous and deceptive. Each of the planets had, however, somewhat varying forebodings, according to the position which it assumed by day or by night in the zodiac or horizon. The twelve signs were assigned to the sun, moon, and planets, as follows: Leo to the sun; Cancer to the moon; and two to each of the five planets—the influence of each of these heavenly bodies being regarded as augmented when it stood in that sign belonging to it, or at points in the other signs which were esteemed peculiarly critical for it.

Thus, the significance of the combined situation of all these bodies received its decisive character from the striking actions of one or more propitious or unpropitious planets, which stood in those positions of increased influence. The so-called horoscope, however, with its derived prognostications concerning the entire future life of the individual, was deduced from that point of the zodiac which appeared in view at the hour of birth. Not only was the planet to whose sign this point in the zodiac belonged the prescribed ruler for life, but also the individual portions of the zodiac, by means of their relations to the single planets, furnished special significations for the horoscope.

The influence of the ruling planet was again essentially modified by the relative positions of the other planets who were entitled to a respectful hearing in the prediction. Indeed, a perfect system finally evolved itself for thus foretelling, from the various situations and aspects at the time of birth, the important events in each year of the life of the newly-born.

In its beginning it possessed much profound thought, since from the positions of the planets at the time of birth, with the aid of their times of revolution, and later, by a theory of all their movements, it could be calculated in advance how they must stand in each year of the individual's life; but the whole soon degenerated into an arbitrary, invented play upon numerical relations. During the lapse of centuries, in which astrology was perfecting and establishing itself in the minds of men, the pre-calculations for the positions of the moon among the planets had been zealously pursued, particularly by the Arabians, and, from the beginning of the fifteenth century, by the people of the Orient. From this period on, these calculations received, aside from their chronological and astrological interest, an augmented importance, on account of the increased demands in naval undertakings and voyages of discovery. The calculations in calendars and ephemerides (in which literature Nuremberg took the lead) were continually amplified, the calendar becoming now concerned with many subjects which grew out of and were nourished by astrological ideas, so that, even at the close of the past century and the commencement of the present, it contained a wonderful mixture of superstitious hints and precepts. These related chiefly to rules of the weather, health, and life; as, for instance, the times favorable for cupping, bleeding, etc. In fact, in many calendars now circulated, there are detailed statements concerning the indications of the planets, etc., and amusing descriptions as to how children will thrive who are born under such and such signs in the heavens.

Moreover, numerous customs and prejudices still reveal the remains of a belief in the stars; such expressions as "unlucky days" and "numbers," "our stars," "saturnine," "jovial," and the like being firmly implanted in nearly every language.

To the superficial view, the whole system of astrology will appear as a vexatious error of mankind; to the deeper observation, however, there is discernible not only the fund of astronomical knowledge acquired, but also a purer sentiment lying at the basis of all, acknowledging man's dependence upon higher powers.

Indeed, soberly considered, the notion that the heavenly bodies controlled the laws of health, etc., possessed one noteworthy attribute, in that it aided in establishing a belief.

The acceptance of particularly mysterious agencies often rendered efficacious such prescriptions, in consequence of the compulsion which they opposed against human convenience and caprice in requiring fulfillment, thereby effecting a salutary influence which in themselves they did not possess.

We have yet to consider another phase of the calendar's being which has a certain connection with the astrological predictions—namely, the "weather prophecies." Among the most cultured of the ancients the weather was not an object of daily interest and regard to the extent which it has become at the present day. In the regions of Asia, Southern Europe, and Northern Africa, where the weather was at first the most zealously studied, the daily as well as yearly changes of temperature, direction of wind, cloudiness, and precipitation, have a far greater regularity than in our climate.

As Nature there also yields her fruits in greater plenitude, the dependence of universal welfare on the weather phenomena is far less painful and disturbing than in our latitudes. Egypt, only, formed an exception, her harvests being largely dependent upon the overflowings of the Nile; but these would be endangered for only a comparatively short portion of the year.

We have already considered how the first calendars took note of the great yearly changes in the weather from their connection with the rising and setting of bright stars in the morning and evening twilight. As culture, however, slowly penetrated the more northerly regions, which are the chief field of the unremitting conflict between the warm equatorial air-currents and the cold polar currents, and which sections are thereby subjected to incomparably greater changes and uncertainties of weather, it was proved no longer wise to associate such variations with the slow changes in the positions of the sun among the stars. Hence the natural inclination to regard earthly as controlled by celestial influences developed itself into a system of manifold predictions concerning weather phenomena, and accordingly the most rapidly moving body in the heavens, the moon, was regarded as the most potential ruler of sudden changes.

It was thus always the problem of the calendar-maker, during the middle ages, to prophesy on the basis of observations of celestial influences, and in a lesser degree also upon the weather itself, certain changes in the weather, and the task was nowhere an ungrateful one; for a successful prediction was a foothold for enthusiastic belief in the prophets, and scarcely ever was a failure regarded with much attention.

The belief in the moon's influence upon the weather is still fostered with a tenacity and universality that seem to lend an especial value to specifications in the almanac regarding the so-called "moon's changes." Many have no concern as to the manner in which the "moon's changes" can affect the weather, but follow simply unconsciously the old astrological inclination in ascribing what is doubtful to heavenly influences; others, on the contrary, accept, indeed, without question, the fact of such influence, but construct for themselves a kind of scientific explanation for it.

The moonlight, they say, dissipates the vapors; and, since the moon determines the ebb and flow of the tides, so it causes also an ebb and flow in atmospheric currents, thus affecting the weather. That sounds quite scientific, yet proves nothing. That such an influence is no longer not incontestable, but placed entirely in doubt, careful records are more clearly proving every year.

The Greenwich Observatory, which is especially engaged with observations upon the moon, has recently fully demonstrated, in its observation register of the moon and weather extending over many years, the complete insignificance of the positions and phases of the moon as affecting the condition of the atmosphere; that all so-called "experiences" to the contrary must be regarded as possessing not the slightest value. In fact, such "experience" is a matter peculiar in itself. The human memory of past events is often a very capricious thing, as we have already illustrated in the words of Kepler, and the remembrance of any one who has not learned to systematically collect pure and conclusive "experiences," free from bias and superstition, upon which to base a rational and conscientious judgment, possesses, as a rule, little value. Scientifically arranged facts are also not proof against erroneous conclusions, and it has too often happened that over-hasty conclusions in science, which were opposed to the clear views of practical men, have been subsequently destroyed by further scientific inquiry; but in the case now considered the aspect is entirely different. Here the so-called practical men are the visionists, and that pitiful remnant of an ancient false belief now no longer cope with the intrinsic worth, the clear and simple results of coincident measurements and calculations. Let us, therefore, throw into the ruins of astrology all still existing presumption to forecast for any extended time the character and changes of the weather, and aid, rather, by careful and honest tabulation of meteorological phenomena, in advancing a science whose foundations have already been laid by men of genius, and which in conjunction with the telegraph is furnishing its timely aid to agriculture and navigation. By means of advanced, systematic research into the laws governing the movements of storms, wind, and air-currents, it enables voyages to be made under increased security and rapidity—furnishing information of incalculable value to the navigator.

From the above review of the astrological belief in destiny and weather, let us again revert to our original question: What significance, then, do the present astronomical rules in the calendar possess, and what is the problem therewith associated in popular astronomical instruction? The reckoning of time has almost wholly emancipated itself from astronomical observations. If we simply continue to reckon the days according to our present arrangement of the year, calling each fourth year a leap-year of 366 days, and assign to each hundredth year 365 days—although it ought to be a leap-year, according to the four-year cycle—and again to each four hundredth year 366 days, we shall be certain to remain for thousands of years in such agreement with the sun that we do not need to concern ourselves in the least in the times of his revolution and positions in the heavens. In fact, the calendar is so perfectly arranged and independent in itself that it requires no special assistance from astronomers. The statements regarding the position of the moon in the zodiac and the situations of the planets, and even the exact times of the moon's changes (if we except the significance of these latter respecting the ebb and flow of the tide), no longer possess any value in daily life if we are free from astrological superstition.

Still, there is a persistent clinging to these ideas, and when, some years ago, the Berlin "Astronomical Year-Book" pointed out the insignificance of the moon's influence on the weather, many protests were received from almanac publishers, especially in Poland and Hungary.

Although, as above stated, the popular calendar has become less and less dependent upon astronomy, yet there is evinced an increased interest among people in the yearly astronomical communications. The dependence of ideas and arrangements on the heavenly phenomena is less, but the desire for an understanding and observation of them is much greater. The prediction of eclipses in the almanac might also be omitted but for the probable danger which would arise from sudden frightening of the people; they can not, however, be well omitted, since every one is desirous of observing at the appointed time the more or less remarkable effects of the phenomena, and of bearing a share in testing the accuracy of the times of prediction.

Moreover, life is constantly demanding greater precision, especially in the measurement of time. The time is not far distant when instruments will be devised for ascertaining in the simplest manner and with the utmost accuracy the time of day from the sun and stars. In general, astronomy will find occasion each year, in ever-increasing measure, to communicate for universal use its advanced determinations and measurements.

The study of astronomy is especially fascinating and helpful to the understanding, in that the mind, translated so far away from the sphere of earth, catches glimpses of the grand and universal outlines of celestial phenomena, and is enabled to emancipate itself from the astrological superstition which we have endeavored to illustrate in the foregoing pages.

SKETCH OF INCREASE ALLEN LAPHAM, LL. D.

THE advancement of American science has been greatly promoted by the co-operation of a host of earnest workers, who, asking nothing in the way of money profit or fame, but moved by the pure love of science for its own sake, have been satisfied to labor in special or local fields, and contribute of what they could produce as free gifts to the sum of knowledge. Such a man of science was Dr. I. A. Lapham, who, according to a most excellent authority, "would have held a more prominent position if he had been more ambitious"; who was, however, well enough known to the people of his own State and in scientific circles everywhere; and the fitting memorials of whose life-work are conspicuously visible in the organization of the Weather Service of the United States and the prominent position Wisconsin has taken as a region where scientific thought is active.

INCREASE ALLEN LAPHAM was born at Palmyra, New York, March 7, 1811, and died on Lake Oconomowoc, Wisconsin, September 14, 1875. His father was a contractor on public works, which, in the days of the son's youth, were chiefly canals; he built the arches of the first aqueduct at Rochester, and the wood-work of the combined and double locks at Lockport, on the Erie Canal, and was engaged in other important works of a similar character. Young Lapham's earlier tastes were guided largely by the business pursuits of his father. He earned his first money by cutting stone for canal-locks and making plans of the locks for travelers; then he became interested in the minerals that were found in the rock-cuts at Lockport, and was thus directed to the observation of nature. He next appears, in 1826, as an aid to his father, an assistant engineer, in laying out a road down the Canada bank of the Niagara River below the falls; afterward on the Welland Canal; then on the Miami Canal, under Byron Kilbourn; and, during the two years from 1827, on the canal around the falls of the Ohio, at Louisville, Kentucky. Here his attention was drawn to the study of the luxuriant flora of that favored region, and he began a collection of plants which grew till it numbered about eight thousand species. He also collected the river-shells of the region, and sent several new species to Isaac Lea, of Philadelphia. His first scientific paper was produced in connection with his work here, and was "a Notice of the Louisville and Shippingsport Canal, and of the Geology of the Vicinity," illustrated with plans, geological sections, and a map, and remarkable for containing the first published notice of the occurrence of petroleum in the cavities of limestone rocks. He was next engaged on the Ohio Canal, at Portsmouth, and published in 1832, in the "American Journal of Science," where his former paper had appeared, a second article on the "Geology of Ohio." In the next year he was appointed Secretary of the Ohio State Board of Canal Commissioners, and removed to Columbus, where he continued his scientific studies under the stimulus of improved opportunities; figured as an officer and active member of the Historical and Philosophical Society of Ohio; and served as a member of a committee appointed by the Legislature to investigate and report upon the subject of a geological survey of the State.

In 1836 he removed to Milwaukee, then in the Territory of Michigan, now in the State of Wisconsin, where, or in the neighborhood, he spent the rest of his life, and where he was identified with the birth and development of the scientific interests of the Territory and State. It was his privilege here to play an important part in the institution of security and the settlement of land-titles, the effects of which were undoubtedly felt in the peaceful settlement of the country and the establishment of its society. New-comers found the Territory as yet unorganized, and without any provisions for the purchase or pre-emption of the public lands. Conflicts might easily arise, and the best claims could have no legal title to rest upon. The settlers agreed upon the course they would pursue, and appointed Mr. Lapham a register of claims, to take charge of the records of all entries of land and transfers. Under this system farm improvements were made in confidence, and, when the land-offices were established, the register's records were recognized and acted upon as authentic evidences of pre-emption right. Mr. Lapham performed this service gratuitously.

Mr. Lapham's life was henceforth spent between the conduct of a business that secured him a competency without superabundant wealth, and the scientific study of all that related, or could be of interest to, the Territory and State. In 1838 he printed a catalogue of the plants and shells found in the vicinity of Milwaukee; and in 1844 he published a comprehensive work on Wisconsin which served for a long time as a standard manual of the character and resources of the State and a guide to immigrants. A treatise on the grasses of Wisconsin and the adjacent States, which was published in the first volume of the

"Transactions of the State Agricultural Society," was the forerunner of a suggestion which he made to the Commissioner of Patents (the Hon. Charles Mason), that the agricultural department of his office might appropriately undertake a descriptive catalogue of all the native, naturalized, and cultivated grasses of the United States. An appropriation was obtained from Congress for this object, and Mr. Lapham was invited by the Commissioner of Patents to undertake the work. It was to include the collection of specimens and their arrangement in books for distribution among State societies and agricultural colleges; drawings and enlarged illustrations of the flowers of each species; the collection and distribution of seeds; the preparation of an exhaustive report on each species, and all facts relating to its economic value; and an expedition to the West Indies or South America for the collection of improved varieties of sugar-cane. Several months were spent in the preliminary arrangements for this work; but when the first quarter's account for salary was presented to the Secretary of the Interior, whose indorsement of it was required by law, that officer, who had not recognized Mr. Lapham's appointment, refused to allow it, saying that so useful and responsible a trust should not be conferred upon one whose political sentiments were not, in all respects, in accord with those of the party in power. Mr. Lapham, though disappointed and a thousand dollars poorer for what he had done, went on with his catalogue and completed it so as to include all the grasses of the United States and Territories, so far as they had been previously described and named, with their localities, geographical distribution, time of flowering, etc., which still remains in manuscript. The subject of authorizing this investigation was again favorably considered by President Lincoln's Administration, but any action upon it was prevented by the war.

In 1867 Mr. Lapham, as chairman of a committee appointed under an act of the Legislature of Wisconsin "to ascertain and report upon the injurious effect of clearing land of forests, and the duty of the State in relation to the matter," made a report covering the whole ground of the subject, which was published as a legislative document.

Though particularly interested in botany, Mr. Lapham was active in many other departments of scientific work. In 1847, writing in one of the city papers on the fluctuations in the level of Lake Michigan, he suggested a method for determining whether it had a tide. His observations on the phenomena of the level, begun as early as 1836, were found to be of great practical value in the preparation of plans for river and harbor improvements, and for all works of the cities of Milwaukee and Chicago in any way connected with the lake and rivers emptying into it, and their importance was recognized in Captain (afterward General) Meade's "Report on the Lake Survey" for 1861. On the 3d of September, 1849, he announced, in a paper of the city, that by a series of observations made every three hours, during the month of August, he had ascertained that there was a slight lunar tide in Lake Michigan. A similar statement was made to the Smithsonian Institution, in connection with the report of his meteorological observations for the month. In a report made to the British Association in 1863, he stated that the amount of this tide was about an inch and an eighth, and that subsequently a self-registering tide-gauge, similar to that used by Professor A. D. Bache on the Coast Survey, was put in operation at the port, the indications of which, deducing the curves from 5,450 half-hourly ordinates, between July, 1859, and November, 1860, gave results almost exactly corresponding with those of his original observation.

Mr. Lapham was engaged, almost from the beginning of his residence in Wisconsin, in the study of the aboriginal earth-works of the State. He was the first to notice that many of the mounds were really gigantic figures of men, beasts, birds, and reptiles; and as early as 1836 he gave accounts in the newspapers of a turtle-shaped mound at Waukesha and of several other effigies of animals. Perceiving the danger of these structures being obliterated, he, availing himself of assistance offered by the American Antiquarian Society, made a systematic survey of many of them, the results of which were published in 1855, under the title of "Antiquities of Wisconsin," in a fine, richly illustrated volume by the Smithsonian Institution. Twenty years later, near the end of his life, he prepared a series of bas-relief models of some of the more characteristic mounds, for the Centennial Exhibition of 1876.

In 1868 fragments of a meteorite, afterward known as the "Doerflinger meteorite," were found on a farm about thirty miles northwest of Milwaukee. A specimen of the stone was obtained for the Wisconsin Natural History Society, of which that body, in consideration of the services he had performed for it, gave a piece to Dr. Lapham. Examining his piece, which had been polished and etched by Dr. J. Lawrence Smith, of Louisville, Kentucky, he discovered in it the familiar crystalline markings known as the Widmannstättian figures, and within these another set of lines, to which Dr. Smith, on their being brought to his notice, gave the name of the Laphamite Markings. A representation of this stone, showing both sets of marks, is given in the new "American Cyclopædia," article "Aërolites." In connection with these observations, Dr. Lapham prepared a complete list of North American meteorites, with a map showing the exact place where every one fell, which, however, has not been published.

Dr. Lapham was one of the first men in the United States, if not the first, to move effectively in favor of general systematic weather observations for the purpose of forecasting and preparing for coming storms. Espy had shown that such a thing was possible; Professor Henry had suggested, in 1847, that the telegraph might be used in aid of such a work; and the Cincinnati Observatory had issued a daily weather bulletin and chart in 1868 and 1869; but Dr. Lapham's efforts were the ones that bore fruit in the shape of national action on a national scale. In 1842 he published, for information and as a stimulus to harbor improvement, a list of marine disasters on Lake Michigan; in 1858 he suggested to a railroad manager, who was building a line of steamers for a lake-ferry, the importance of procuring a knowledge of coming storms. The manager answered, politely, that he had more confidence in the size and speed of his boats than in storm-signals. He afterward addressed a lake-captain on the subject, and the sailor replied that he had "little time to investigate meteorological papers, and had never been impressed with the opinion that our changeable and fickle climate could be put under any rules by which mariners might be guided with any certainty or much profit." The idea, however, was gradually commending itself to the moneyed men of Chicago, when, in 1869, Dr. Lapham met the Hon. E. D. Holton, who was just about to go to attend the meeting of the National Board of Trade, at Richmond, Virginia, and explained his scheme to him. Mr. Holton secured the passage, by the National Board of Trade, of a resolution which Dr. Lapham had drawn up, commending the project to the consideration of the Government. A bill, introduced by General Paine, of Wisconsin, for the establishment of the Weather Service, was passed, and on the 15th of March, 1869, "Old Probabilities," as the office was for a long time nicknamed, was installed. Dr. Lapham was appointed in November, 1871, Assistant Signal-Officer at Chicago, and had the pleasure of sending home, at the end of a month, a draft for "the first considerable sum I have ever received as salary for any scientific work." The amount was $166.67.

In 1873 Dr. Lapham was appointed, in accordance with an act constituting the Geological Survey of Wisconsin, Chief Geologist, with authority to select his subordinates. The fitness of the appointment was universally recognized, but by some oversight the nomination was not sent to the Senate for confirmation. The work was prosecuted by him with great energy and most fruitful results for nearly two years, by which time "the political aspect of the State had changed, and there had been an upheaval of strata of which our geologist had taken no notice." He first learned through the newspapers that he had been superseded. Nearly a month later (March 21, 1875) he received a letter from W. R. Taylor, Governor, notifying him that "all authority (if any possessed by you), as Chief Geologist, ceased and was annulled on the 16th day of February" previous.

On the 14th of September, of the same year, Dr. Lapham, having retired to his farm on Lake Oconomowoc, had just finished a paper on the capacity for fish production of that and other small lakes of Wisconsin. Then he went in his boat upon the lake. He was found a few hours afterward, lying in the bottom of the boat, dead from heart-disease.

The nature and variety of Dr. Lapham's scientific pursuits are illustrated by his biographer, Mr. S. S. Sherman, in an anecdote: "When asked, by a gentleman well known in scientific circles, in what department of science he was laboring, he replied, 'I am studying Wisconsin.'" The variety and accuracy of his knowledge made him a kind of encyclopædia—a ready reference on almost every subject; and Mr. Sherman fills several pages of his biography with a list of questions on which he was consulted by farmers, citizens, miners, archæologists, amateurs, or scientific men like Professor Agassiz (to whom, apologizing at one time for not being able to send a better supply of certain fishes he had asked for, he pleaded that he was "not an expert fisherman"), Asa Gray, and Alfonso Wood. Professor Wood placed him "among the five or six most active and intelligent botanists in the country." Professor Gray declared him the pioneer botanist of his State, whose name would be inseparably connected with its flora, and called a new genus of plants after him, *Laphamia*. He was one of the founders of the Wisconsin Academy of Sciences, Letters, and Arts, an LL. D. (1860) of Amherst College, an honorary member of the Royal Society of Antiquaries of Copenhagen, and a member of most scientific associations of the United States. The list of his publications, some of the more important of which have already been indicated in the course of this article, numbers about forty-five titles. Ten of them are upon geological subjects, nine on subjects of botany and natural history, seven climatological and meteorological, three on the antiquities and the Indians of Wisconsin, three upon physical phenomena (the effects of the destruction of the forests, the great fires of 1871, and the great fresh-water lakes), and one is the article "Wisconsin" in the "American Cyclopædia." The others are topographical, or relate to miscellaneous subjects. The last was "The Laws of Embryonic Development the same in Plants as in Animals," which was published in the "American Naturalist" of May, 1875. Besides these, he left a mass of valuable notes and manuscripts, showing the fruits of industrious research.

CORRESPONDENCE.

THE AFRICAN IN THE UNITED STATES.

Messrs. Editors.

HAVING read with much interest Professor Gilliam's article on "The African in the United States," and agreeing with his general conclusion that "they must forever remain an alien race among us," it seems to me that there still remains something to be said, and that now is the time to say it, and this must be my excuse for this appeal to your courtesy.

The obstructive Chinese legislation was received at first, by most thinking men in the country, not in direct contact with the question, with aversion, and a regret at a departure from one of the first principles of our Government, viz., the equality of man. But most of us are now satisfied that while this American life is a furnace which melts into good Americans the peculiarities of all white races, the attempt to assimilate a race of different color, and of a civilization older than ours, and one that has resisted conquest, oppression, and time, would certainly have resulted in failure, and that a majority of citizens of Chinese birth or descent, on the Pacific slope, would have made of that section practically a foreign land.

That the case of the negro, as stated by Professor Gilliam, is hardly as bad, is evident. The negro is not the heir of an ancient and scientific social order. What knowledge he has of social order and political forms is American, and, however much he may develop, his development will still follow these lines, and there will hardly be a race war of virulence enough to attract the attention of the country as a whole. At the same time it is very certain that the fact of color will forever keep the two races separate, and that as the negroes realize the voting strength of mere numbers there will be a tendency among them to gather in certain sections of the country in overwhelming power, and by the perfectly legal means of the jury system and the ballot drive the whites, not only from office, but from among them. The process will be slow and gradual, and there will be probably neither occasion nor opportunity for the interference of the Federal power. But the concentration of an alien and unassimilable race in any section of the country, especially in a section of so much strategic importance as the mouth of the great river that is the future door to our house—however much their civilization may be an outgrowth of our own—is certainly a political arrangement to be avoided if possible. And how is it to be avoided? Professor Gilliam gives us no hint except the vague regret that the San Domingo purchase was lost to us. The history of the centuries is before us. The long education of the African is complete. The dark continent is opened. The slave has received his freedom. The generation that intervened between the slave and the conquering freeman of old has nearly passed with our bondmen of to-day. All things indicate that the time has come when steps must be taken toward the solution of the problem of the colored race among us, or we must pay in the future, as in the past, for our neglect or mistakes in dealing with this matter, with losses and suffering, perhaps again with blood.

A bill passing Congress establishing a steam mail line to Liberia from some Southern port—Charleston, or preferably New Orleans—with a subsidy for mail-carriage, sufficient to insure its being kept up, however great the expense, would have reasons in its favor worthy of the following considerations:

Our merchant marine is destroyed, and must for national and economic reasons be rebuilt, and, in spite of our present prejudice against subsidies, capital must at first be attracted to this field by national bounties. This is the way England's supremacy was organized, and is kept up. It is the way France and Germany are increasing their fleets, and there is no other way. Trade and travel follow regular steamship lines. This needs no demonstration. England's successful efforts in this direction keeps her to-day the workshop of the world. The wealth of Africa is at this moment the cynosure of industrial nations. England, France, and Belgium, by arts of peace or war, are pressing forward to take possession of its coast. It is only a question of time before, on some petty pretext, Liberia will be attacked and pass into England's possession, unless we cultivate closer relations. It is a country capable of great development. It is already progressing, and its governmental forms and traditions are American. The establishment of a steamship line to Liberia would produce the following results: The formation of a stable government in Africa, sprung from and modeled after our own. A nation that would assimilate and develop the native tribes instead of destroying them; a nation that would have our customs, our energy, and our tools, know and buy our wares, would, by the railroad-building arts they take from us, conquer and control the heart of Africa, and, above and beyond the trade considerations, would settle forever, in accordance with natural development, the question of race hatreds among us, by affording a career in a new and virgin field, to every turbulent, reckless, and energetic spirit among the colored Americans. These are the advantages. The cost is the direct mileage to steamers of one thousand tons or upward capacity, less the indirect advantage of trade. The profit of the freight and passenger traffic is probable during the second year. The time is now. But the fact remains that the Solons at Washington are more interested in the distribution of the offices than the future prosperity of the country, and that our republic is so strong that no safety-valve is needed until after the explosion. C. E. Chittenden.

Scranton, Pa., *February* 15, 1883.

RAILWAY CONSOLIDATION.

Messrs. Editors.

I always enjoy and value your able journal, and feel in reading it that the actual facts are treated of without any fear or turning aside.

I must express particularly the degree of education I have received from the paper on railway consolidation as especially exemplified by the Union and Central Pacific roads.

I see now, what I had failed before to recognize, that only complete consolidation of all the routes to the Pacific is needed to perfect the contribution of all the railways can offer to rendering that coast Utopian in fact.

There were once impressions in the minds of ill-informed men that two gigantic and immensely subsidized corporations, the Pacific roads and Pacific Mail, had combined to wring all that was possible from the public that contributed so generously to give them existence.

Another fancy was, that rates were so much higher to points far this side of San Francisco, that shippers sent goods through and brought them back, at way-freight rates, to save money. It was even asserted that paying through rates would not secure the right of unloading *en route*.

Newspapers not inspired with integrity have even started the rumor that merchants who would not sign a bond committing themselves to sending all their freight by the Pacific roads were not given favorable rates. How sad that such things have been written and said; and how bitterly must men feel who read the last sentence of your exhaustive article, and are conscious that, before reading the decimals that so accurately measure the blessings of consolidation, they thought that roads untrammeled by legislation might become imbued with some selfish motive!

The odious term "monopoly" being treated with scientific accuracy becomes a charming expression, and, beyond question, the time will soon come when its perfection may be arrived at by the simple result of all transportation being consolidated in the hands of one man. Then it can be done at a minimum profit, from the fact that there will be but one family to maintain from the net earnings, and, of course, a railway-man is prone to all economy.

Very few feel called upon to pay their own fare, or the hauling of the cars in which they deny themselves the simple necessaries of life, sturdily confining themselves to the bare luxuries.

The tramps which the engines so often cast aside, mangled masses of flesh and old clothing, may have done more for practical progress than the railway "beat" who lords it at the stockholders' cost. But this is no matter, if the magnate who hurls along over unguarded crossings, with no regard for life or limb, can only go sixty miles an hour, and arrange a consolidation in a few moments.

It is well that your magazine can so readily dispel "fundamental misconception" by the clear enunciation of "economic laws" as to remove all the old ideas, in twelve pages of comparative lines and decisive decimals.

So guarded, the public is safe, and the "politician and the press," other than the strictly scientific, are needless.

Grateful for information so serene and simple, I am, yours very truly,

L. W. Ledyard.

Fernwood Farm, Cazenovia, N. Y., *February* 19, 1883.

THE COPYRIGHT DISCUSSION.

Messrs. Editors:

My object in writing the article which appeared in your March number, on "Piratical Publishers," was to provoke such a discussion of the subject of international copyright as its importance demands, and I am neither disappointed nor displeased with the rather severe editorial strictures which followed it. But, while I am quite willing to concede that some of your arguments have sufficient force to weaken, in a measure, those presented by me, I am firm in the conviction that most of my positions have been unsuccessfully assailed.

I write, however, now, to prevent misapprehension, by stating—what I ought to have said before putting my name to the article referred to—that I have no personal concern in the question under discussion, being no longer a republisher, and having no interest, pecuniary or otherwise, in the publishing business. Also that I have—or, rather, the publishing house which has so long borne my name has—for more than thirty years past, paid a liberal sum to all the English publishers whose works it reprinted, and that the most cordial relations between the parties have always been maintained; so that my article was not written in vindication of my own conduct, but, as already stated, for the purpose of presenting such extreme views on one side of the question as should call forth the strongest points that could be presented on the other, and thus bring about the fullest possible discussion on the subject. I trust your criticism is an earnest of what is yet to follow from those who may have access to the pages of "The Popular Science Monthly."

LEONARD SCOTT.

EDITOR'S TABLE.

THE NEW SCIENTIFIC WEEKLY.

SINCE our last issue the new weekly, "Science," an American journal, much on the plan of "Nature," has made its appearance at Cambridge. We had been much interested in the previous announcements of the project. The cultivators of science in this country are certainly sufficiently numerous to maintain an organ by which they can promptly communicate with each other and with the world on those multifarious results of investigation for which there have hitherto been but very inadequate means. The want of such a periodical has been long and urgently felt, and attempts have before been made to meet it, though not with success. Two things are required to put such an enterprise upon a satisfactory basis—the general and hearty support of scientific men, and capital enough for all the preliminary needs of the undertaking. "Science" has secured both. That it has the abundant confidence and co-operation of American scientific men in all departments of inquiry is attested by the large number of eminent names that have appeared in the newspapers in connection with it, and also by the statement of the prospectus that "'Science' has secured in advance the good-will and active support of a large body of the most competent scientific men of the country, as will sufficiently appear upon publication of a few numbers."

Equally necessary was a liberal provision of funds to float the enterprise. Notwithstanding the alleged interest in science with which our age is so abundantly credited, it remains doubtful if a journal designed mainly for the wants of specialists can be remunerating, at least until after a considerable period of time. It must chiefly appeal to the intellectual requirements of advanced men; but these form a large clientage. Working upon the frontiers of scientific thought, it will be conversant with inquiries that are, to a considerable extent, beyond popular reach. Records of the progress of research and criticisms of original work must inevitably be technical, and therefore but little attractive to the non-scientific classes. "Science" will, of course, have its popular features, but, if it does tolerable justice to the body of American investigators and gives us a weekly conspectus of the condensed results of current research in the scientific world, it can devote but limited attention to popular science. But, with abundant capital, it is independent.

The numbers of "Science" that have thus far appeared fulfill every reasonable expectation, and give assurance that the journal will take a high rank among periodicals of its class. There is, of course, room for criticism,

"SCIENCE": Published weekly at Cambridge, Mass. Moses King, Publisher. Proprietor, "The Science Company": President, Daniel C. Gilman; Vice-President, Alexander Graham Bell; Directors, D. C. Gilman, A. G. Bell, G. G. Hubbard, O. C. Marsh; Treasurer, Samuel H. Scudder, of Cambridge. Pp. 28. Published every Friday; price 15 cents per number, or $5 a year.

as there would be at any rate, whatever the excellence of its plan or the thoroughness of its execution; but its sagacious editors and enterprising managers may be best trusted to detect its deficiencies, and to repair them by self-correcting experience. The first number, of course, exemplifies the plan of the weekly. Besides its prospectus, and the opening introductory article, there are interesting communications from Professor Langley, Samuel Kneeland, Captain Dutton, and E. H. Hall, together with an admirable notice, by Professor Asa Gray, of Alphonse de Candolle's work on "The Origin of Cultivated Plants," contributed to the "International Scientific Series," and soon to appear in English. After a brief review of the "Natural History of Minnesota," we come to perhaps the most distinctive feature of the journal, in the "Weekly Summary of the Progress of Science" which is given in the first number, under the successive headings of Mathematics, Physics, Chemistry, Metallurgy, Geology, Meteorology, Physical Geography, Geography, Botany, Zoölogy, Vertebrates, Physiological Psychology, and Early Institutions. Several of these have subdivisions, as Acoustics, Optics, Photometry, and Photography, under Physics; and Fish, Reptiles, Birds, and Mammals, under the title of Vertebrates. The information is of the most varied kind, but all refers to recent observations, experiments, or inquiries. Each distinct statement or item is numbered, for convenience of future reference; and, in the ten pages here devoted to the weekly progress of science, we have seventy-nine of these brief articles, each signed with the initials of a responsible editor in his own branch. We know something of the immense care and labor which such a department involves. Following this is "Intelligence from American Scientific Stations," with "Notes and News," general and personal, and a copious list of "Recent Books and Pamphlets on Scientific Subjects." Our new journal is thus packed with the concentrated nutriment of science, and will have value wherever the substantial data of inquiry are appreciated. "Science" is sure to contain a great deal of information that is of general importance, and we cordially recommend it to the patronage of all classes who care anything for the positive advance of knowledge in this country.

It is proper to add that we are ourselves interested in the success of "Science," with special reference to our own line of work. The law of progress is ever through division of labor, which in this field takes the shape of specialty of publication. We have felt the need of such a periodical as "Science," because we have been pressed to do the work which it now undertakes, but which it has been impossible for us to perform. A monthly can never compete with a weekly or with the daily press in giving scientific news; as to do that work well requires a definite and comprehensive organization for the purpose, and a frequency of publication that shall secure the prompt diffusion of scientific intelligence. "Science" will do this work effectually, and, by becoming an organ of accredited discovery and authorized opinion, will leave us free to devote ourselves to popularizing and diffusing the approved results of scientific inquiry.

INCENTIVES TO THE PURSUIT OF SCIENCE.

But while welcoming our new coadjutor with unqualified approbation as to its purpose and method, we confess to some misgiving about its first formal utterance on "The Future of American Science," which it is declared almost in a tone of jubilation is to be distinctively and supereminently utilitarian. The utilitarian passion of the American people, it is here maintained, must also become the animating impulse of American science. Criticism may seem ungracious in this place, yet we can not refrain from asking if it is quite appropriate to the character of such an enterprise to begin by letting down instead of elevating the ideal of inspiration in the pursuit of original science.

After commending the men of the past who have made eminent achievements in pure science in this country, the writer says: "The leading feature of American science, however, and that which most distinctly characterizes it, is its utilitarianism. True there are in our country able investigators working in scientific fields which do not offer the promise of material reward; but, notwithstanding this, it remains still true that those sciences whose principles are capable of useful application are the most zealously cultivated among us, and attract the largest number of students. Nor is this to be at all regretted. Research is none the less genuine, investigation none the less worthy, because the truth it discovers is utilizable for the benefit of mankind. Granting even that the discovery of truth for its own sake is a nobler pursuit, because a less purely selfish one, does it become any the less noble when it is ascertained that the truth thus discovered is capable of important applications which increase tenfold the happiness of human life? It may readily be conceded that the man who discovers nothing himself, but only applies to useful purposes the principles which others have discovered, stands upon a lower plane than the investigator. But when the investigator becomes himself the utilizer, when the same mind that made the discovery contrives also the machine by which it is applied to useful purposes, the combined achievement must be ranked as superior to either of its separate results."

There is here a reversal of the gradation in the motives to scientific study which has been too long and too clearly recognized to be lightly brushed aside. The most exalted incentive in the pursuit of truth is that high appreciation of it which makes its bare discovery the supreme compensation of the investigator. There is deeply implanted in the human mind a desire to find out the secrets of nature; and there is a pleasure in the satisfaction of this desire which has ever been the sharpest spur of scientific research. It is, moreover, this impulse to seek the truth of nature for the simple love of it that has played much the most prominent part in the progress of science. But, though animated by a noble purpose men are human still, and so they have been also impelled to scientific discoveries by the lower impulses of personal ambition, or because of the honor and fame they will confer. There is, besides, an inducement to scientific inquiry on account of the usefulness of its results in practical life, or the motive of public utility. And, finally, there is the desire to reach new results for the selfish individual advantage of turning them to profitable account: this is the mercenary motive, and is, of course, the lowest of all.

Now, human motives are often a good deal mixed, yet dominant intentions are not difficult to detect. In this case, what a man does with his discovery must be taken as proof of his intention in making it. If a man finds out a new fact, makes a new observation, or works out a new principle, and then communicates it to the world, he is to be fairly credited with the motive of laboring for the increase of knowledge for the sake of knowledge. If he is solicitous about the priority of his result, we know that he prizes the personal honor that it will confer. If he makes a discovery and applies it to some useful end, and then presents it to society for the promotion of the public good, he is to be credited with the philanthropic motive of contributing to the common utility. But, if he makes a discovery, and, shrewdly keeping it to himself, applies it to a practical use, and then patents it for his own profit, the act qualifies the motive as selfish and sordid, and of the lowest kind. The writer in "Science" maintains that where an invention is tacked on to a discovery, the compound result must be superior to its separate elements. But invention is not science, and can not count in ranking scientific achievement. Rank is here determined solely by the elevation or the degradation of the motives by which men are impelled to research. Davy made discoveries in combustion which enabled him to invent the safety-lamp, but he at once gave it freely to the world. Dr. Wollaston discovered the malleability of platinum, and devised the means of producing it on a commercial scale, but he kept his inventions a secret and acquired great wealth by them. The two transactions, however, are ranked in scientific history as of two orders, and as widely apart as generosity is from greed.

Inventions are excellent things, and we have certainly no objection to patenting them; but, as we have said before, they are not parts of science, and when introduced in connection with the work of scientific discovery they serve only to mark the lower purpose for which it is pursued. We are not responsible for this mixing up of patent-rights with science, and protest against the use of them to magnify utility, and cast virtual disparagement upon the highest motives of scientific investigation. The writer upon "The Future of American Science" identifies the interests of invention with those of science in a way that antiquates the simple-minded devotee to truth for its own sake. He says: "The inventive genius of this country is pre-eminent. We reap the benefits of it on every side. Our houses are more comfortable, our railways more safe, our fabrics cheaper, and our education more thorough, because of useful inventions. Becoming restive at the slow progress of discovery, the inventor has himself assumed the *rôle* of investigator; and the results of his researches appear in the records of the Patent-Office. In the olden times, the investigator was content to make his discoveries, and to publish them, consecrating to science the knowledge thus obtained. His more modern representative carefully treasures what he has discovered until he has exhausted its practical application. In consequence, the discoveries upon which many of the most important scientific inventions of the day rest will be searched for in vain in scientific literature. The telegraph, the telephone, and the electric light are inventions which illustrate the fact now stated in an eminent degree."

The significance of the new departure, which substitutes the lowest for the highest inducement to scientific labor, is here sufficiently apparent. It is the old fogy of "the olden times" that was content "to make his discoveries, and to publish them"; it is his wide-awake "modern representative" that keeps his results to himself until he can turn them to the purposes of private speculation, through the agency of the Patent-Office. But if it is not to be the policy of the coming scientific utilitarian to publish, pray what is the function of the new weekly? And, when the inventor gets "restive at the slow progress of discovery," and proposes to take hold of it himself we may commend his enterprise, but there are some things of which it is desirable that he should be reminded. First of all, and as a matter of fact, scientific truth has been a slow growth of ages. "The telegraph, the telephone, and the electric light" illustrate a good deal more than is here stated. Centuries of labor, and the blood of generations of indefatigable scientific workers, had been expended in experimental researches upon electricity, before the facts were disclosed and the principles established which have now become available in their useful applications. Priestley's "History of Electricity," published a hundred and sixteen years ago, was even then a ponderous volume, though it was but an epitome of older successful work, and took little note of the labors that failed to issue in new results. Science is, indeed, a *very* slow growth, and long periods of unremitting toil must pass before its final stages of flowering and fruiting are reached, even in those comparatively few cases where the fruit can be turned into gold. There are those who have at length the good fortune to shake the tree of scientific knowledge when its fruit is ripe, and they may be alert to clap the padlock of the Patent-Office on their results so as to be able to use them with profit; but there can be no greater mistake than to assume that the time has come when scientific workers generally can be encouraged to devote themselves to the reaping of the profitable pecuniary harvest of past researches. In the broad field of original scientific investigation, not one part in a hundred is capable of being cultivated with any possible hope of turning its results to pecuniary account. A hasty glance at the pages of "Science" is quite sufficient to show the utter futility of supposing that the multifarious labors there indicated can ever issue in any pecuniary advantage to those who perform them.

But the writer in "Science" pushes his case still further, as follows:

> The science of to-day is in thorough accord with the spirit of the American people. They are proud of every achievement it makes, and are satisfied with the returns it is giving them for their investments. To continue this *entente cordiale* should be the object of every scientific worker. He may the more readily concede some practical return for the facilities for investigation which the people have furnished, since the march of discovery is not in the least hindered but rather promoted by the practical application of the new truth it develops. His attitude toward invention should be appreciative and cordial. He should cast aside all prejudice against the man of patents and practical devices, and should stand ready to welcome the investigator, in whatever garb he appears.

Again we protest against this confounding of science with business. The writer talks about the American people investing in science, and being satisfied with the returns. But science is not a thing to be invested in; people invest in patent-rights and stock-companies, and may be well pleased with their returns, and proud of their inventors, but they are not therefore patrons of science. Let the man of patents stand upon his own merits, and go for what he is worth, and not construe the success of his business operations as an evidence of the high public appreciation of genuine scientific work.

The disparagement of scientific investigation from its highest motive, by the writer in "Science," is undisguisedly and almost offensively explicit. He says, "While the scientific cynic may condemn the utilitarianism of our age, the more liberal man rejoices in it." The devoted student, impelled by the loftiest spirit, which refuses to be influenced by lower considerations, is not well characterized as a "scientific cynic"; nor is he who works from the lowest motive entitled to applause as "the more liberal man." We reiterate that the nobler motive has been a thousand-fold more potent in creating the great body of scientific truth than the more sordid motive. The one supreme lesson taught by the history of science for the last three centuries is, that the world mainly owes its great results to the single-minded devotion of its cultivators, to the pursuit of truth for the sake of truth alone. This has ever been, and it must always continue to be, the most elevated and generous, as well as the most powerful mental motor in the prosecution of truly scientific investigations. That there is a wide-spread and an active tendency in this country to degrade science to the low, money-making level of a society immersed in material interests and given over to the pursuit of wealth, is no doubt true, but it is a state of things to be deplored and to be withstood, rather than to be complacently accepted and applauded. Let men pursue science from whatever motive they will—all valid results are valuable—we only object to this formal surrender of the highest ground at a time and in circumstances which require that it should be steadfastly maintained. It is neither possible nor desirable to disconnect science from its useful applications, but as Goethe says, "the useful may be left to take care of itself"; there is no danger of its being neglected. Our objection is to this inaugurating something like a national policy of science, animated by the mercenary spirit which it has been the glory of science to have always resisted as the proper or highest motive of its cultivation.

HINDRANCES TO THE SCIENCE OF POLITICS.

We briefly notice, in its appropriate place, a new book having the title of the "Science of Politics," and we reprint a portion of its important preliminary chapter, designed to point out the nature and limits of this alleged science. The author shows the valid grounds upon which it rests, and the certainty of its future development; but he at the same time indicates very clearly the formidable difficulties which hinder, and will long continue to hinder, the recognition of politics as a regular branch of scientific inquiry.

And among these obstacles attention is called to one which seems singularly enough to be itself a product of political progress: it is that a conception of a scientific politics may be expected to meet with most resistance under governments theoretically most liberal and advanced. We should certainly anticipate that where there is the greatest intelligence, and the form of government is most popular, there would be the greatest tendency to the study of political institutions from a scientific point of view; and accordingly we might expect that the subject would be congenial to American students of political affairs. And yet it is probable that nowhere else will there be found so wide-spread and pronounced a skepticism in regard to it as in this country. If we could take the sense of the American Congress upon this point, who can doubt that its members would decide with the greatest unanimity that there is, and can be, no such science as that of which our author undertakes to lay down the elements? Nor can we for a moment expect that the law-makers in all our State Legislatures would disagree with such a congressional decision. So much, at any rate, may be assumed, that, whether or not there be such a thing as a possible or actual science of this kind, American politicians generally are profoundly ignorant of it, and will, moreover, have little interest to inquire seriously into its claims. Nor can we escape the conclusion that, of all classes of the community, none are so little concerned about politics, as a problem of principles, as the class of men who make politics a profession. This is a curious state of things in a country where we hear on every hand that intelligence is the first condition of the perpetuity of popular government. While intelligence is held to be so fundamental a necessity in this republic that the state actually assumes the duty and the responsibility of molding the minds and characters of its citizens into conformity with our political requirements, yet the idea that there is any science or fixed order of relations, or inevitable working of cause and effect, in the political sphere, will be generally scouted as chimerical.

What is the explanation of this anomalous state of things? The answer is, that the most popular forms of government engender the worst forms of politics, and favor and foster states of mind that exclude all considerations of a scientific nature. This may be an unpalatable conclusion, but unpalatable conclusions are often true. We have to face the disagreeable fact that it is under the most liberal and perfected political institutions, so called, that the incalculable element of personal caprice in political affairs comes into greatest ascendency. We speak of kingly rule as the type of personal government, but personal government is only seen in its highest power and effect where each citizen has become a sovereign. It is only where the self-seeking of the single monarch is multiplied by millions in a nation of potential office-holders, that the selfishness of personal politics rises to its maximum influence. It is only in a country where everybody is eligible to office, where the incentives to office-seeking are universal, where politics has become such a national passion that the whole scheme of public education is subordinated to it, that personal aspirations and the interests of selfish ambition will dominate unrestricted in the management of public affairs. And it is undeniable that politics with us is coming to be more and more a business, a vocation to be pursued for profit and emolument by successful office-seeking. Under such a system the winning politician will not be the man of intelligence, deliberation, and principle, but the man skilled in all the low arts which will insure political success. He will be the shrewdest operator of the partisan mob. Nothing is more notorious than that under the working of our popular political institutions, the best men go to the wall, and the worst men come to the front. By the very conditions of the case, it is the crafty operators, the long-headed managers, caucus manipulators, party intriguers, and brazen, indefatigable demagogues, who secure the offices. From the General Government down through all the ramifications of legislation and administration to the petty town officials, the places are filled by partisan professionals, so that the first presumption in regard to an office-holder is that he is unfit for the place. And such is the extent of this field, and the intensity of the competition in it, that the preparation for it is of the most absorbing nature, so as to afford a virtual guarantee that the incumbents of office will be profoundly ignorant of all that it is most important for them to know. These are of course not the men to appreciate the scientific elements and aspects of governmental affairs. Such considerations are not available for their purposes. Everything like statesmanship, the forecast of distant consequences in government policy, will be excluded from their minds by the pressure of immediate interests, the advancement of personal projects, and the achievement of political success in accordance with current ideas. The politician looks out first for himself, and all his study is to get a better thing than he already has. Only the one at the top can get no higher, and his soul is devoured by the ambition to be re-elected By the very instinct of the situation, which involves calculations of immediate effect, the politician will be comparatively indifferent to all those slow-working agencies which yield enduring results of the highest value, and which it is the great object of science to elucidate, and of genuine statesmanship to recognize in government policy.

In dealing with the hindrances to the due consideration of a science of politics, the author of the work referred to remarks as follows upon the adverse tendencies which are to be met with even under the best governments:

The topic is naturally relegated to the region of caprice and accident, or to that of tentative experiment and spasmodic contrivance. This intellectual consequence is intensified by the fact that all governments—and not least those known at the present day as the freest, and, on the whole, the soundest—are habitually made the arena of purely ambitious contention, of selfish aspiration, and even of corrupt conspiracies against the public well-being. The wider the territorial area of any particular government, and the more complicated and extensive its essential mechanism, the more opportunity is there for the exhibition of personal, or, at the most, of local self-seeking. So far as this prevails, politics becomes degraded into a mere vulgar struggle for money, office, or power. All actual reference to scientific considerations is excluded. The tone of public thought and sentiment becomes proportionately infected, and all the claims which might otherwise be asserted on behalf of politics to take its place by the side of other sciences dealing with such moral elements as the human will meet with a skeptical repudiation.

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES. No. XLIII.

The Science of Politics. By Sheldon Amos, M. A., author of "The Science of Law," etc., late Professor of Jurisprudence in University College, London. Pp. 490. Price, $1.75.

It is doubtful if any book could be offered to the American public of which they would be so little able to judge what it might be about, as a treatise on "the science of politics." It would rather be expected that the writer would choose some such title to give respectability and character to new political theories of his own, and it would at any rate be anticipated that the work would be largely of a visionary and speculative nature. Yet no such expectation would have been justified in the present instance. Professor Amos has given to the world an instructive and valuable contribution to the important subject which he has felt it incumbent upon him to undertake. It is first of all a moderate, judicious treatise, indulging in no extreme or extravagant views, and imbued throughout with the true scientific spirit. Professor Amos has this claim, which is probably an advantage in the treatment of his subject: he is not a man trained in the field of physical science who has felt that he had a mission to carry physical methods of study over into the political region to open a new dispensation of political philosophy. On the contrary, he is an erudite student of history, law, and civil institutions, and has made jurisprudence and the working of political constitutions a matter of lifelong and critical investigation. His preparation has been in the general field which furnishes the subject-matter of his book, and he has come to the large conception of a science of politics through inquiry into the relations of political phenomena. From this consideration, his work will have a weight and a practical character which no amount of preparation in the special sciences could have given it. We are of opinion that Mr. Spencer's "Development of Political Institutions," dealing strictly with the subject from the point of view of historic evolution, is probably a more valuable contribution toward the organization of a political science than this work of Professor Amos, and yet it may not be so well adapted to interest general readers in the claims and grounds of this new subject. At all events, Professor Amos's book is better suited to the state of mind of politicians, who, being generally of the class of lawyers, will be more familiar with his data and the questions he discusses than they would be with the rigorous inquiries into the genesis of political ideas worked out by an analysis of primitive society. The plan of the work before us may be best gathered from a statement of the topics dealt with in its successive chapters. These are: I. "Nature and Limits of the Science of Politics." II. "Political Terms." III. "Political Reasoning." IV. "The Geographical Area of Modern Politics." V. "The Primary Elements of Political Life and Action." VI. "Constitutions." VII. "Local Government." VIII. "The Government of Dependencies." IX. "Foreign Relations." X. "The Province of Government." XI. "Revolutions in States." XII. "Right and Wrong in Politics."

Obviously the first implication of science is of laws or principles of a general nature, or that are universal in their operation. A science of politics, therefore, if there be such a thing, must deal with political phenomena in their most comprehensive forms, or as exemplified under wide diversities of constitution. It will be seen from the titles above enumerated that the range of discussion in the present volume is broad, and deals with all the chief fundamental problems relating to the policy of government. Under the forms of diverse institutions, Professor Amos seeks to trace the tendencies and influences that are at work for good or for evil, and by which the value of the accompanying forms must be judged. The book, in the nature of things, can not be as spicy as a treatise on local politics, appealing to the bias and prejudice of patriotic feeling, but just for this reason its influence will be salutary and wholesome. We greatly need that catholicity of view in dealing with political subjects which it is the object of science to illustrate and enforce.

Description of Houghton Farm by H. E. A.; with experiments on Indian Corn, 1880-'81, by Manly Miles, Director of Experiments. With a Summary of the Experiments with Wheat for Forty Years at Rothamsted. Cambridge: Printed at the Riverside Press. Pp. 75.

Experimental scientific agriculture—anything truly entitled to the name—is perhaps one of the most difficult things that a man can undertake. Experimental science, anyhow earnestly pursued, is the hardest kind of work. Mere experiments are, of course, easy enough, and it is easy to parade their results and talk about new discoveries, of which people generally know nothing. But to make experimental investigations tributary to any real advance of knowledge, to get new and valuable results which will stand, or to give greater precision and trustworthiness to accepted conclusions, is as far as possible from easy, and is, indeed, so difficult as to be but rarely attained. It is quite a mistake to suppose that laboratories grind out new truth with the regularity of a flouring-mill. Elaborate experiments may go on for years, and nothing come of them worth preserving. It is exactly this difficulty in getting it that makes scientific truth so precious. It is like diamond-digging, only the "finds" are much less frequent, and infinitely more valuable.

But, if in each of the sciences, with perfected equipments of research and a comparatively narrow field, it is so hard to add anything new to the stock of knowledge, how much more difficult must it be when the attack is made upon a whole group of mutually dependent sciences! The farm, taken as an arena of experiment, is itself a congeries of laboratories. The phenomena involved are physical, chemical, geological, meteorological, and broadly biological—that is, embracing the economy of vegetal and animal life, from mildews to fruit-orchards, from insects to vertebrates. To know the nature of the soil, the nature of the air, the nature of fertilizers, the nature of plants and animals of all kinds, so as to study them in their vital connections by experimental processes that shall bring out valuable and lasting results, is hence, as we have said, one of the most formidable of tasks.

In the first place, there will arise all the difficulties encountered in the pursuit of the special sciences, with the disadvantage that the means of investigation are very rarely so perfect. But the peculiar and most formidable difficulty of agricultural science arises from the fact that the farm is itself a grand laboratory of nature, which imposes its own conditions of inquiry. And the first of these conditions is, that Nature must be taken at her own pace. Her processes go on at their own rates, and can not be much forced. The natural changes involved in agricultural effects proceed slowly, and the experimenter must conform his plans to this fact. The changes of soil, the action of fertilizers, the improvement of crops, the culture of stock, involve slowly accumulating results, require time, and, in addition to knowledge and skill on the part of the investigator, he must also have patience and perseverance, remembering that the fruits of his efforts belong to the future. Agricultural science, if honest, can not strike for immediate results; that scientific farming which demands something to display promptly, like prize-cattle and prize-crops, or that seeks to astonish the neighborhood, is a sham, and only brings an excellent thing into unmerited disgrace. This is what must be, and what is shown by abundant experience. The farm establishments started by rich men for the promotion of agricultural science, and which have come to nothing, may be counted by hundreds. On the contrary, the one which has a world-wide reputation for having made the largest contribution to agricultural progress is working by a system which requires a long series of years to develop its results. The Rothamsted farm of Messrs.

Lawes and Gilbert has been forty years in getting under way, and its most important results are still matters of hope and belong to the future. This is in accordance with the spirit and requirements of true scientific agriculture.

We have been led to these remarks by an examination of the pamphlet before us, which reports the initial steps of a new American attempt at scientific agriculture. Six hundred acres of Orange County land, named Houghton Farm, and owned by a wealthy manufacturer, Mr. Lawson Valentine, have been devoted by him to "a long-cherished plan for doing something toward the progress of American agriculture." The proprietor resolved that to attain this object he would constitute "a scientific department devoted to agricultural investigation and experiment, and that such department be of the highest order"; and that "the farm operations be carried on in accordance with the best-known methods and under the best possible organization and management, with a view of educating and enlightening others by furnishing valuable examples and results in practical agriculture." A good deal of hard thinking and difficult work was here laid out for somebody, and very naturally Mr. Valentine, a business man, cast about for able help in carrying on his enterprise. He had the good fortune to secure the services of Dr. Manly Miles, of the Michigan Agricultural College, a man well prepared for original agricultural investigations, to take the direction of the farm experiments. It was proposed to attempt for Indian corn in this country what had been done for wheat by Lawes and Gilbert in England—that is, to carry its cultivation through a course of years on assigned plots of ground, for the purpose of determining the quality and quantity of the product with different fertilizers, different modes of treatment, etc. The pamphlet before us contains Dr. Miles's report on the work of 1880–'81. This report lays down the method to be pursued, and embodies the first results. It indicates the plans of drainage adopted, gives the previous history of the plots of ground, describes the selection of seed, and gives the carefully tabulated results from unmanured plots, plots treated with farm-yard manure, and a considerable number of the most important artificial fertilizers. The mechanical operations of culture are carefully described, the peculiarities of the season recorded, and there is a minute description of the precautions taken to determine accurately the quantitative results of the matured crops. The main results, of course, assume a tabular numerical form, but Dr. Miles has also introduced very successfully the graphic method of conveying generalizations and comparisons to the eye by means of diagrams. There are all the indications in this report of intelligent, conscientious, painstaking, and persevering work. The document is undoubtedly valuable for the positive information it contains, although from the nature of the case the first results of such a trial-series of experiments must have the lowest value of any terms of the series. Single experiments in agriculture are worth but little, and only become valuable as they are verified. Time and continued research are indispensable for the elimination of error.

No one can carefully examine this report without recognizing that the experiments were intelligently planned and thoroughly executed as far as they went, giving promise that by rigorously carrying out the system adopted still more valuable results will be attained. We have been informed that, when Dr. Miles undertook the work, he did so under the explicit condition that he should have charge of the experiments for at least a period of ten years, that time being indispensable to achieve anything worthy the name of a contribution to agricultural science. Yet, after a year of preparation, and two seasons of systematic work, presto, the director of experiments at Houghton Farm is found installed as professor in the Agricultural College at Amherst, Massachusetts. What there was about these initiative experiments on Indian corn which Mr. Valentine found unsatisfactory does not appear in the document before us; but we have heard that the director of experiments was complained of as "slow." This is probably because striking results did not come out fast enough to suit the enterprising proprietor; but, if so, it does not augur well for the usefulness of Houghton Farm. That highest order of progressive agriculture which is really to educate a community is not accompanied by monthly displays of sky-rockets. A "fast" director of experiments may astonish the natives with his performances, but cautious deliberation is one of the first conditions of scientific success. Quickstep, hurrah-boys scientific agriculture, which demands that there must be something to show by a week from next Saturday that will make a rattle in the newspapers is quite too-too to be of much value to anybody. No doubt your enterprising American is not going to dawdle forever over miserable trifles, but for that simple reason not much is to be expected of him in the way of the substantial advancement of science.

Anatomical Technology, as applied to the Domestic Cat: An Introduction to Human, Veterinary, and Comparative Anatomy. With Illustrations. By Burt G. Wilder, B. S., M. D., and Simon H. Gage, B. S. New York and Chicago: A. S. Barnes & Co. Pp. 575. Price, $4.50.

This book is intended as a guide to students in their early dissection-work. The experience of the authors has led them to choose the cat for the subject to be treated, as being the mammal most nearly resembling the human species, which is readily obtainable, and of convenient size to dissect and preserve. They begin at the beginning, and give full directions in regard to weights and measures, terminology, note-taking, instruments and their care, killing the animal, etc., and throughout the book the methods of dissecting and preserving the several parts are fully detailed. The book does not aim to describe all the muscles, veins, nerves, etc., of the animal, and it gives a large proportion of space to the viscera. The illustrations are numerous, and where possible the technical names are printed upon the several parts. There are numerous lists and tables, and many references to other publications, which afford collateral reading. While this is a work adapted to a physiological laboratory, where, no doubt, it has been prepared, yet it will be of service to many who are denied the opportunities of such an institution. It will be a very useful book for young students at home, who propose to pursue the medical profession. Like all other manipulation, the earlier dissection is practiced the better, and certainly the earlier the student gets an outline knowledge of practical anatomy by his own examination of anatomical structures, the greater will be his advantage when he comes to the crowded and multifarious studies of the medical college.

Experimental Physiology, with an Address on Unveiling the Statue of William Harvey. By Richard Owen, C. B., M. D., F. R. S., etc. London: Longmans, Green & Co. Pp. 216. Price, 5 shillings.

The advancement of the healing art by means of experimental research is the subject of which this little volume treats, and which also forms the theme of the address that is prefixed to it. In England vivisection has been closely restricted by act of Parliament, and a society exists whose aim is to entirely suppress the practice. Dr. Owen demonstrates the unreasonableness of the supersensitive members of this society, by showing how immensely the physician's power of relieving human suffering has been extended by the knowledge gained by Harvey, the discoverer of the circulation of the blood, by Hunter, and by later experimenters, through vivisection. He mentions aneurismal and intra-abdominal tumors, fevers, and nervous diseases as among the disorders for which vivisection has suggested means of successful treatment. Among the lesser ills he mentions the pain in teeth that have been filled, and states that a method of devitalizing the tooth-pulp was discovered through experiments on three dogs. "As many millions of human beings have been and will be, in the present generation, relieved through Dr. Arkövy's vivisections from sufferings equal to, perhaps greater and much more prolonged than, those which were endured in behoof of those millions by three dogs. Add to these millions the generations of the so-relieved in time to come."

Physics, and Occult Qualities. By William B. Taylor. Washington: Judd & Detweiler, Printers. Pp. 50.

This is the retiring president's address, delivered before the Philosophical Society of Washington on the 2d of December last.

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that we are not surprised to find much new matter which has never before been fully presented in any systematic treatise, and, to those who wish to keep abreast with the times and with the latest views of geologists on all important questions, we can recommend a perusal of Professor Geikie's work, the value of which to the student is greatly enhanced by his copious references to authorities and works consulted.

Annals of the Astronomical Observatory of Harvard College. Volume XIII. Part I. Micrometric Measurements. Cambridge, Massachusetts: John Wilson & Son. Pp. 204.

The work tabulated in this volume was done with the equatorial telescope of fifteen inches aperture, from 1866 to the close of 1881, under the direction of Professors Winlock and Pickering, the successive directors of the observatory, and includes observations of double stars, nebulæ, the satellites of Saturn, Uranus, Neptune, and Mars, the asteroids, comets, and occultations. Micrometric determinations of position, except in the cases of small stars near the equator and in and near the nebula of Orion, the results of which have appeared in former volumes, have formed only a small part of the work done with the large telescope; and the present volume records chiefly the miscellaneous micrometric work that has been accumulated during the intervals of other investigations.

Quintus Claudius: A Romance of Imperial Rome. By Ernst Eckstein. From the German by Clara Bell. New York: William S. Gottsberger. 2 vols., pp. 313, 303. Price, $1.75.

This is an attempt to reproduce in a life-like form, and with the interest of a romance, the manners and moods of a past age. With reference to the particular era selected, the period of imperial Rome at the close of the first century, the author observes that it bears, in its whole aspect, a stronger resemblance to the nineteenth century than perhaps any other epoch before the Reformation; and that hardly another period "has ever been equally full of the stirring conflict of purely human interest, and of dramatic contrasts in thought, feeling, and purpose." The numerous allusions to peculiar features of the time are explained in foot-notes.

Traits of Representative Men. By George W. Bungay. New York: Fowler & Wells. Pp. 286.

This, says the author, is not a book of biography, but of pen and pencil pictures of men of the time who have distinguished themselves in their respective callings, from which the young may derive lessons that will be of service to them. Among the thirty-five men whose biographies are given, with their portraits, politics, literature, the clergy, finance, and art are represented, but science not at all.

PUBLICATIONS RECEIVED.

*** *Authors and others, sending papers and monographs for notice, will please specify, for general information, where they can be procured.*

The Manual Training School of Washington University, St. Louis, 1882–1883. C. M. Woodward, Secretary. Pp. 45.

Admission of Women to Universities. By W. Le Conte Stevens. New York: S. W. Green's Sons. Pp. 26.

The Foundation Principle of Education by the State. By Samuel Barnet. Boston: New England Publishing Company. Pp. 11.

Annual Report of the School Committee of the City of Gloucester, Massachusetts. M L. Hawley, Superintendent. Pp. 66.

Connecticut Agricultural Experiment Station, Annual Report, 1882. S. W. Johnson, New Haven, Director. Pp. 114.

Zoölogical Society of Cincinnati, Annual Report, 1882. Frank J. Thompson, Superintendent. Pp. 16.

Pitcher Plants. By Joseph H. James. Pp. 11.

The Storage of Electricity. By Henry Greer, New York Agent, College of Electrical Engineering, 122 East Twenty-sixth Street. Pp. 64.

Buffalo Naturalists' Field Club Bulletin; Vol. I, Nos. 1 and 2. Buffalo, New York: George Wardwell. Pp. 48. Bi-monthly. $1 a year.

Nature of Electricity and Cosmic. By Raald Arentz. Hartford, Connecticut: Case, Lockwood & Brainard Co. Pp. 24.

Value of the "Nearctic" as one of the Primary Zoölogical Regions. By Professor Angelo Heilprin. Philadelphia. Pp. 20.

Observations of the Transit of Venus, 1882, at the Lick Observatory, Mount Hamilton. By Professor David P. Todd, of Amherst College. Pp. 8.

State Museum of Natural History, and Completion of the Palæontology of New York. (Legislative Document) Albany. Pp. 28.

Alcohol a Factor of Human Progress. By William Sharpe, M.D. London: David Bogue; New York: G. P. Putnam's Sons. Pp. 14. Sixpence.

Esmarch, Antisepsis, and Bacillus. By William Hunt, M.D. Philadelphia. Pp. 22.

Scrofula and its Gland Diseases. By Frederick Treves, F. R. C. S. Philadelphia: Henry C. Lea's Son & Co. Pp. 77. 10 cents.

The Prevention of Insanity. By Nathan Allen, M. D., Lowell, Massachusetts. Pp. 23.

Vaccination: Its Fallacies and Evils. By Robert A. Gunn, M.D. New York: Nickles Publishing Company. Pp. 38, 25 cents.

From Zone to Zone. A Prize Poem. By Frank D. Y. Carpenter. Pp. 22.

POPULAR MISCELLANY.

Aberrations in Fog-Signals.—Mr. Arnold B. Johnson, of the Light-house Board of the United States, has been pursuing on our coast parallel investigations with those reported some years ago by Professor Tyndall on the aberrations of audibility of fog-signals The results of this work, as summarized by Lieutenant-Commander F. E. Chadwick, U. S. Navy, who aided in the investigation, are, that navigators, when attempting to pick up a fog-signal, must give attention to the direction of the wind. If they are to the windward of the signal, in a moderate breeze, the chances are very largely against their hearing it, for there is nearly always a sector, of about 120° to windward of the signal, in which it either can not be heard at all, or is very faintly heard. As they bring the signal to bear at right angles with the wind, the sound will almost certainly in the case of a light wind increase, and will soon assume its normal volume, being heard almost without fail in the leeward semicircle. Fog appears not to be a factor of any consequence whatever in the question of sound. Signals may be heard at great distances through the densest fogs, which may be totally inaudible in the same directions and at the same distances in the clearest atmosphere. It seems established by numerous observations that the best possible circumstances for hearing a fog-signal are in a northeast snow-storm, and they appear to be best heard then with the observer to windward of the signal. In light winds the signal is best heard down the wind or at right angles with the wind. The worst conditions for hearing sound seem to be found in the atmosphere of a clear, frosty morning on which a warm sun has risen and has been shining for two or three hours. The result of the whole is, that "the mariner will do well, when he does not get the expected sound of a fog-signal, to assume that he may not hear a warning that is faithfully given, and then to heave his lead, and resort to the other means used by the careful navigator to make sure of his position." (Washington: Judd & Detweiler, printers.)

Herbert Spencer and the Land Question.—Mr. Herbert Spencer sends to the "St. James's Gazette" (London) the following communication, explanatory of his views on the ownership of land: "During my absence in America, there appeared in the 'St. James's Gazette' (27th of October, 1882) an article entitled 'Mr. Herbert Spencer's Political Theories.' Though, when it was pointed out to me after my return, I felt prompted to say something in explanation of my views, I should probably have let the matter pass had I not found that elsewhere such serious misapprehensions of them are being diffused that rectification seems imperative. Before commenting on the statements of your contributor, I must devote a paragraph to certain more recent statements which have far less justification. In old days among the Persians, the subordination of subject to ruler was so extreme that, even when punished, the subject thanked the ruler for taking notice of him. With like humility I suppose that now, when after I have been publishing books for a third of a century 'the leading critical organ' has recognized my existence, I ought to feel thankful, even though the recognition draws forth nothing save blame. But such elation as I might otherwise be expected to feel is checked by two facts. One is that the 'Edinburgh Review' has not itself discovered me, but has had its attention drawn to me by quotations in the work of Mr. Henry George—a work which I closed after a few minutes on finding how visionary were its ideas. The other is that, though there has been thus made known to the reviewer of a book of mine published thirty-two years ago, which I have withdrawn from circulation in England, and of which I have interdicted translations, he is apparently unconscious that I have written other books, sundry of them political; and especially he seems not to know that the last of them, 'Political Institutions,' contains passages concerning the question he discusses. Writers in critical journals which have reputations to lose usually seek out the latest version of an author's views; and the more conscientious among them take the trouble to ascertain whether the constructions they put on detached passages are warranted or not by other passages. Had the Edinburgh reviewer read even the next chapter to the one from which he quotes, he would have seen that, so far from attacking the right of private property, as he represents, my aim is to put that right upon an unquestionable basis, the basis alleged by Locke being unsatisfactory. He would have further seen that, so far from giving any countenance to communistic doctrines, I have devoted four sections of that chapter to the refutation of them. Had he dipped into the latter part of the work, or had he consulted the more recently published 'Study of Sociology' and 'Political Institutions,' he would not have recklessly coupled me with Mr. George as upholding 'the doctrines of communism, fatal alike to the welfare of society and to the moral character of man'; for he would have discovered the fact (familiar to many, though unknown to him) that much current legislation is regarded by me as communistic, and is for this reason condemned as socially injurious and individually degrading. The writer of the article in the 'St. James's Gazette' does not represent the facts correctly when he says that the view concerning ownership of land in 'Social Statics' is again expounded in 'Political Institutions'—'not so fully, but with as much confidence as ever.' In this last work I have said that, 'though industrialism has thus far tended to individualize possession of land, while individualizing all other possession, *it may be doubted* whether the final stage is at present reached.' Further on I have said that 'at a stage still more advanced, *it may be* that private ownership of land will disappear'; and that '*it seems possible* that the primitive ownership of land by the community . . . will be revived.' And yet again I have said that '*perhaps* the right of the community to the land, thus tacitly asserted, will, in time to come, be overtly asserted.' Now it seems to me that the words I have italicized imply no great 'confidence.' Contrariwise, I think they show quite clearly that the opinion conveyed is a tentative one. The fact is, that I have here expressed myself in a way much more qualified than is usual with me; because I do not see how certain tendencies, which are apparently conflicting, will eventually work out. The purely ethical view of the matter does not obviously harmonize with the political and the politico-economical views; some of the apparent incongruities being of the kind indicated by your contributor. This is not the place to repeat my reasons for thinking that the present system will not be the ultimate system. Nor do I propose to consider the obstacles, doubtless great, which stand in the way of change. All which I wish here to point out is that my opinion is by no means a positive one; and, further, that I regard the question as one to be dealt with in the future rather than at present. These two things the quotations I have given above prove conclusively."

Value of the Evidence of Stone Implements.—Professor Putnam suggests in his report, as curator of the Peabody Museum of Archæology, that it will not do to draw too large inferences from the finding of stone implements. That our recent Indians, he says, "used many exceedingly rude stone implements can not be questioned, and even to-day, among the Western tribes, stones picked up at random are used for various domestic purposes, and when a camp is changed many such are left, with other things which are of too little value to be taken away. From these facts it is evident that the ruder implements and utilized natural forms are not a certain evidence of the period of development of the people who made use of them. That we, in camping out, are so often forced to make use of stones, shells, bones, and withes of roots or bark, should be considered in drawing deductions from the rude character of any set of implements."

Responsibility of Criminal Lunatics.—Dr. S. S. Herrick, of the Louisiana State Board of Health, has published (New Orleans) a plea in favor of enforcing the responsibility of criminal lunatics, to the extent at least of putting them where they can do no harm. He starts with the obvious proposition that "the welfare of the sane members of society is vastly more important than the liberty, or even the life, of a dangerous lunatic," and expresses the belief that probably at least three sane persons are acquitted on the "insanity plea" for every insane criminal convicted. A vast amount of silly sentimentality, he continues, "is effused on criminals, both sane and insane; as if a few such worthless wretches deserve more consideration than the great mass of well-behaved and respectable people. It is indeed shocking to take the life of a madman, judicially or otherwise; but it is simply bad management to allow a lunatic to commit an act for which a sane person would be punished, and still worse to risk its repetition." Dr. Herrick objects to capital punishment for any class of criminals; but he advises that the insane be held amenable to punishment like other criminals, and be made to know that its infliction is sure. This will operate as a restraint upon them, and conduce to security of life and property and to the welfare of the insane. It may be alleged, adds Dr. Herrick, "that the restoration of penalties upon the insane is a relapse toward the barbarism of the past. The answer to this is, that by their immunity from punishment is demonstrated a deviation from progress, inasmuch as it practically increases crime and provokes violent and unlawful retaliation."

What is Adulteration.—What is the wrong of adulteration if the adulterant is not injurious is shown up by Professor Albert B. Prescott, of Ann Arbor, in one of the papers of the Michigan State Board of Health. Adulteration infringes upon the right of every person—unrestricted except by considerations of sanitary welfare and public police—to decide for himself what he shall eat. "An adulteration is a fraud, a deception, a counterfeit. It is systematically concealed from the purchaser. Its object is to induce people to accept an article which they would not accept for the use then wanted, if it were not for the deceit. To sell an admixture of coffee and chiccory, if the terms and proportions of the mixture are printed on the wrapper in a way to have them seen by the purchaser is not adulteration. To sell oleomargarine under its own distinctive name, with no credit borrowed from butter, is not an adulteration. But to supply sugar made from corn-starch for the ordinary sugar made from cane-juice, or to deal out milk-and-water or skim-milk for entire milk, is an adulteration—a violation of the right of the consumer to obtain his food on his own discretion." The plea that may be made, that the adulterant is as wholesome as the real article "is not to be heard at all; it belongs to the consumer to judge for himself what he will provide for his own table." Even if the falsification be not committed to injure health, it is directly objectionable on sanitary grounds, for it is a violation of a great safeguard of health. To the plea that people are not really deceived by the sophistications, but that they are understood, tolerated, and even preferred by customers, "let it be replied, if the pretense is so thin as to deceive no one, and if the admixture is in demand for use as it is, the pretense can the more easily be dropped, and at any rate the admixture must go under its own description and by its own name. Not a single article, unless indictable as a positive poison, need be withdrawn from the market."

Festivals of the Pagan Iroquois.—Mrs. Erminie A. Smith gave an interesting account, at the late meeting of the American Association, of some peculiar festivals and superstitions of the Iroquois Indians. About half the Iroquois, she said, are not Christians, but worship a Great Spirit, a god of love, and look to him with great confidence. Their religion is not idolatrous, but quite spiritual. Their only private worship is burning tobacco, and an occasional solitary dance of the squaws. There are eight annual festivals, at which varied Romish, Jewish, or Protestant forms have been engrafted on the ancient dancing, games, and incense-burning. The Tuscaroras of Western New York have hardly a trace of their old religion. About half the Senecas are still pagan. The Onondagas have numerous festivals, beginning with the feast at the first new moon of the new year, at which the chiefs occupy four days in narrating the teachings of Handsome Lake, who nearly a hundred years ago introduced a new form into their religion. On the next three days the chiefs and their followers "put their sins in the wampum" (i. e., confess). The clans are then divided into sides for the gambling, which lasts three days. A white dog is strangled and presented to the winning side, who decorate it and dance around it. Afterward the dog is thrown into the fire, and the sides are reunited. Then there are war-dances, and the women dance without lifting their feet from the ground. At the tapping of the maple-trees there is a war-dance to bring warm weather and make the sap flow. A seven days' festival is held at corn-planting, and there are also strawberry, bean, and green-corn festivals; the latter is preceded by a hunt. In the gambling the women sometimes play against the men for the silver brooches which cover their dresses. The last public festival is at the corn-gathering, when there is a repetition of the confession of sins. A special dance takes place at the death of a medicine-man. The property of an ordinary dead person is often played for. Friendships are cemented by dances. It is a sad fact that the pagan Iroquois are better than their Christian brethren. No wonder the missionaries have great obstacles, when all the immoral white intruders are counted as Christians. New York has much to answer for, and should care more for her Indians than for the Greenlanders and Hottentots. The author dwelt on the great influence for good of one good woman. Great results have flowed from some schools founded long ago. Mrs. Smith introduced the following names of the moons, or months, in the Mohawk tongue: January, old beech-leaves fall; February, bull-frog on pond; March, moss all falls; April, turkeys gobble; May, plant corn; June, strawberries begin; July, corn getting ripe; August, corn quite ripe; September, all ripe and dry; October, getting cold; November, colder; December, very cold.

Suicide in Switzerland.—Mr. Wynell-Mayow has attributed the high rate of suicide that has been remarked in Switzerland to Calvinism, and assumes that that republic "is the most Calvinistic country in the world." Mr. William Westall, in the London "Spectator," shows that he is wrong in two points. Calvinism is not the faith of the majority in the confederation, but only of a part of three fifths of the population, among whom Protestants of every denomination are included, and it has long ceased to be a living faith there. It would be more reasonable to ascribe the prevalence of self-murder to drink, for Switzerland is one of the most drunken countries in the world. The fact is, however, that suicide is not excessively prevalent among the Swiss. Self-murders are committed in the country, but not by natives. Thus the statistics show that, of 263 suicides committed in the Canton of Geneva between 1873 and 1878, 48·3 per cent were committed by foreigners, and only 26·6 per cent by natives of the canton, the others having been natives of other cantons than Geneva.

Folk-Lore of the Elder and the Juniper.—The elder and the juniper were formerly sacred to the German goddess Bercht Holda, and many traces of their former sanctity remain in popular customs. Thus elder-branches are scattered around, and juniper is smoked, on the day of *Corpus Christi*. The German name of the juniper (*Wachholder*) appears to be a corruption of a combination of words, which, when analyzed, are found to signify the living tree of Holda. A number of superstitions may be traced back to the former connection of the elder-bush with the goddess. Witches are thought to produce bad weather by stirring water with branches of elder. Some believe that to burn elder-wood will bring harm to the house. It is not considered lucky to cut down elder-bushes or juniper-trees without asking their consent, and offering an exchange. February was the month of Holda, and Lady-Day was her particular day. On that day, the women were accustomed to dance in the sunshine, having elder sticks in their hands, with which they struck the men who came near them. The ancient Prussians made offerings to the god of death under elder-trees, and the pollen was considered dangerous. The Slovaks made elder-men out of the pith, to be servants of the death-god; and the Poles never ventured to cut down the bush except under the protection of an incantation. When any one died in Hildesheim, the undertaker took the measure for his coffin in silence with an elder-rod, and the driver of the hearse had a whip of elder-wood. The gods of the lower world were propitious to every one who planted an elder. In Vinchgau, in the Tyrol, it was thought that any one on whose grave a transplanted elder-bush became green was happy; the bier of the dead was a cross made entirely of elder-wood. The wood was worn as a charm for protection against epilepsy, and whoever took hold of the amulet acquired the disease. Similar superstitions were attached to the juniper. The berries were holy; the plant, bearing green berries along with ripe ones, gave protection against the small-pox, as well as against witches. The pollen was considered invaluable for the young growth of the wood. The spirits loved to dwell among the bushes; whoever could make himself invisible could change himself into a juniper-bush, which no one would dare to touch. A statue of the Virgin was surrounded by juniper, and the Christ-child had a queen-bee in his hand. The dead were burned with juniper-wood. The hornbeam had such an affection for the juniper that it would die if its neighbor was plucked up. The linden, the hypericum, the hazel, the service-tree, and the ash, were also consecrated to Holda, and the first tree in the list played a prominent part as a magic tree, with which many different usages are associated.

Advantages of Cremation.—Dr. W. H. Curtis, of Chicago, in an address before the American Public Health Association, at its Savannah meeting in 1881,* summarizes the objections to the disposition of the dead by burial as consisting in the pollution of the soil, air, and water—a real danger in crowded cemeteries; the peril from body-snatchers; and the possible danger of persons being buried alive. The objection to cremation, that it is a heathen rite and not a Christian one, is dismissed as untenable; it may be as Christian as any other method. There remain but two objections that deserve notice. Cremation may be used to destroy evidences of crime; and it is too costly for general use. The former objection is outweighed by the advantages that might be derived from the general adoption of cremation, and can be obviated by the

* Riverside Press, Cambridge, Massachusetts.

enforcement of easy precautions. The cost is reducible to a very small amount by means of the modern appliances. "In the improved furnaces of to-day the body does not come in contact with the fire at all, only with an intense heat of 2000° or more. At this temperature the body simply withers away into a pure white ash. The gases generated are burned in a separated chamber adapted to the purpose, and no smoke, odor, or other unpleasant phenomena occur, to offend the sensibilities of any one, be they ever so acute. To attain these nearly perfect results, of course, costs money. The furnace can not be erected in this country for less than from three to five thousand dollars—a mere *bagatelle* compared with the cost of some of our cemeteries. The fuel necessary to attain this high temperature, with the necessary attendance, makes the expenses of the incineration of a single body about fifteen dollars. The apparatus used by the Danish society at Copenhagen effects the cremation in about an hour, and costs only from five to seven shillings. After all, the costliness of cremation does not seem to be such a very great objection. Of course, if we are forced to send the body to Washington, Pennsylvania, to Milan, to Padua, or any other of the existing crematories, the privilege is placed beyond the means of any but the rich. But when the crematories are more numerous and accessible, as they no doubt soon will be, the necessity for an expensive lot in an expensive cemetery, an expensive casket, and all the pride, pomp, and circumstance of a funeral *à la mode*, may be dispensed with."

Instruction in Physics.—The quality and best methods of education in physics may be stated as the subject of the address of Vice-President Mendenhall before Section B of the American Association at its recent Montreal meeting.* Presupposing that the diffusion of information, or instruction, is an important means of advancing science worthy of a place by the side of original research, and that teaching should be accompanied—not taking the place of it or surrendering itself to it—by experimental work, he suggests that quantitative work, and that the best possible under the circumstances, should occupy the attention of the student, while illustrative experiments and the qualitative work necessary to a good understanding of the subject should be relegated to the lecture-table of the instructor. That which the pupil gets which is of most worth in his course in a physical laboratory is not a familiarity with the principles of the science, but a training in the methods of investigation in use among physicists, including a knowledge of the use and abuse of experiment and the necessary limits of our knowledge derived therefrom. The study which he ought to make of errors, instrumental and accidental, will be of great value in various fields. It is better for the laboratory to contain a few instruments of precision than a large number of inferior performance and accuracy. It is not a matter of great importance upon what particular department of physics a student shall spend his time and strength. The underlying principles of the method are common to all, and skill in one begets facility in the others. To sum up, the course of study in physics for the undergraduate collegian should include a sufficient training in mathematics to enable him to apply his knowledge with ease and facility to the more common physical problems; a thorough and exacting course of text-book and lecture-work, in which the application of his mathematical knowledge would be made, and during which all illustrative experiments necessary to a complete understanding of the text should be exhibited by the instructor from the lecture-table; and, finally, this to be supplemented by a course in the laboratory in which more attention is paid to the quality than to the quantity of work done; during which every problem is discussed, as far as possible, both mathematically and experimentally, and especial attention is given to the discussion of the results of experiment and of the more elementary portions of the theory of errors. "Considering the work as thus divided into three parts," says Professor Mendenhall, "I am unable to see which is the least essential."

* Printed at the Salem Press, Salem, Massachusetts.

Work for Amateur Astronomers.—Professor Edward C. Pickering, of the Harvard College Observatory, invites amateurs who have small telescopes to the observation of the variable stars, and assures them that by systematizing their work, and each selecting a particular field, they can not only observe with more satisfaction to themselves, but may aid the progress of science. Some may make real discoveries, and they are promised all the credit they may deserve for them, if they give due early notice of the fact. Steady and repeated observations of the same object are wanted once or twice in every month, in order to secure determinations of their light-curves or variations. This point has been heretofore to a large extent omitted, and only the fact of variation, its period, and its extremes, have as a rule been ascertained. Amateurs may do service in this line, while professional observers are attending to more delicate points. Professor Pickering has published a pamphlet giving directions and the other information needed to secure intelligent observations, which may be had on application to him at Harvard College Observatory, Cambridge, Massachusetts.

Roman Remains.—Mr. Alfred Tylor has recently described, before the Royal Institution of Great Britain, some Roman remains that were discovered last year in London about nineteen feet below the present surface of the ground. They include several cinerary urns, one of which, fifteen inches high, was of glass, containing the results of the cremation of human bodies, and a remarkable turned vase of stone. Four of the urns were inclosed in leaden *ossuaria* without solder, in the inside of one of which was found an emblem of Mithra, the Persian sun-god. Some of the other urns were protected by roofing-tiles. The coins found during the excavations bore dates from A. D. 60 to 300. The Mithraic emblem was probably of a date soon after A. D. 50.

Dizziness and Deafness.—Dr. William James, of Harvard University, has made some experiments to test the modern theory that the semicircular canals, instead of being connected with the sense of hearing, serve to convey the feeling of movement of the head through space, which, when intensified, becomes dizziness. It occurred to him that deaf-mutes, having their auricular organs injured, might afford some corroboration of the theory, if it were true, by showing a smaller susceptibility to dizziness than persons with normal hearing. Of 519 deaf-mutes examined by subjecting them to a rapid whirling, 186 were wholly insusceptible of being made dizzy, 134 were made dizzy in a very slight degree, and 199 were normally, and in a few cases abnormally, sensitive. Nearly 200 students and instructors in Harvard College, supposed to have normal hearing, were examined for purposes of comparison, and but a single one proved exempt from the vertigo. These results seemed to Dr. James to support the theory which was the object of his inquiry. It occurred to him that those persons not affected by dizziness ought also to lose their power of orientation when diving under water; but the experiments that were made to test the correctness of this view were so varied in their results that no conclusions could be drawn from them.

Errata.—*Messrs. Editors:* Permit me to call attention to a few errors in the first column of page 714 that make nonsense of what I am quoted as saying of the supposed "lignified snake." According to my remarks, as published in the Washington "Star," in line two, "rudimentary" should read "rejectamentary." In line twenty-seven, "larva" should read "liber." In lines thirty-three, thirty-four, "without interference with the growth or soundness of the tree" should read "except where the bark is already loosened, a supposition which involves the idea of death or decay in the tree, and consequent incapacity to renew tissue.

C. V. Riley."

NOTES.

In the twenty-third "Forestry Bulletin" of the Census-Office, the total consumption of wood for fuel in the United States during the year of the census is estimated at 145,778,137 cords, the value of which was $321,962,373. Of this quantity, 140,537,490 cords were used for domestic purposes; 1,971,813 cords by railroads; 787,862 cords by steamboats; 358,074 cords in mining and amalgamating the precious metals; 266,771 cords in other mining operations; 1,157,522 cords in the manufacture of brick and tile; 540,448 cords in the manufacture of salt; and 158,208 cords in the manufacture of wool. During the same year 74,008,972 bushels of charcoal were burned, the value of which was $5,276,736.

That plants have the faculty of adapting themselves to suit a new environment has been curiously illustrated in the case of some Australian acacias that were introduced to the Neilgherries of India in 1845. At home, these trees flower in October, which is there a spring month. The transplanted acacias continued in India to flower in October till about 1860, when they were observed to flower in September; in 1870 they flowered in August; in 1878 they flowered in July; and lastly, in 1882, they began to flower in June, the spring month which corresponds most nearly with the Australian October. The trees imported since 1845 have not yet gone so far back in the time of their flowering.

A female hippopotamus, which was presented to the London Zoölogical Society in 1853, by the Viceroy of Egypt, has just died, with the exhibition of all the signs of old age. Her mate died in 1877, after having lived twenty-seven years in the garden. As the condition of the teeth and bones indicate that the animals could hardly have been able to live as long in their native wilds as they did under attention at the park, the conclusion is drawn that the limit of life of the hippopotamus is about thirty years.

Dr. Joseph Kidd relates, in "The Practitioner," a history of the course of disease in a family, the effect of which is to illustrate strikingly, if it does not demonstrate, the transmissibility of Bright's disease. A woman, two of whose brothers had died of this disease in early manhood, who herself died of it when sixty years of age, was the mother of twelve children, seven of whom also died from it, and grandchildren, of whom two at least are afflicted with kidney-disease.

A story is told of a woman in Boston who discovered and located a leak in the waste-pipe of a wash-bowl, by taking advantage of the fondness of cats for the oil of valerian. Having put two cats in the parlor, where an offensive odor was perceived, the woman poured the oil into the basin of an upper room and watched for the result. The cats shortly began to sniff the air and move toward a closet through which the waste-pipe ran, then jumped upon a shelf and purred as if enjoying a great luxury. The wall was cut away to expose the pipe, and a considerable leak was found at the very spot pointed out by the cats.

The Russian admiral, Count Frederic B. Lütke, known as the "Patriarch of the Fleet," a distinguished navigator of more than half a century ago, has recently died. He circumnavigated the globe in 1817–'18; was employed during the four successive summers, 1821–'24, in scientific surveys of Nova Zembla, from which rich additions to the knowledge of the Arctic regions were derived; and from 1826 to 1829 he commanded an expedition of the corvettes Séniavine and Moller to Kamchatka and other parts of Northeastern Asia, Behring's Sea and its archipelagoes, and Alaska, in the course of which extensive collections were made and much knowledge was acquired.

Professor John Nichol, speaking in his "Historical Sketch" of American literature of the non-existence of international copyright, says that "this gross injustice to the authors on both sides of the Atlantic, for the benefit of the publishers on one, leads to the intellectual market being glutted with stolen goods. Considerations of interest in business are of course everything; those of principle or art or patriotism nothing."

England has lost an active and highly appreciated scientific student by the death of Edward B. Tawney, Assistant Curator of the Woodwardian Museum, Cambridge. He was the son of a clergyman, and was born in 1841. For six years before going to the Cambridge Museum, he had been Assistant Curator of the Bristol Museum. He was author of numerous papers on topics in geology, was versed in several Continental languages, and relished the masterpieces of literature; thus showing in his life that science is not narrow or its pursuit humdrum.

The United States Commission of Fish and Fisheries is about to build, in connection with its new station there, an aquarium, to be devoted to biological researches of every description, at Wood's Hole, Massachusetts. Preparations are being made at the adjoining station for the artificial propagation of cod, mackerel, halibut, and other fishes useful for food.

The death is announced of Johann Benedict Listing, a German philosopher who was distinguished for his studies in recondite questions in physics—in such matters as the world ordinarily does not, or does not try to, understand. His most important discovery was a law, called after him, Listing's law, in physiological optics, which relates to the position of the eyeball when it turns from looking at one object to another, without movement of the head. Other studies related to the geometrical qualities of knots, the inversion and perversion of geometrical figures, helices, the complexes of space, and similar puzzling conceptions.

Dr. Carl Hornstein, Professor and Director of the observatory at the Carl Ferdinand University, Prague, died December 22d, aged fifty-eight years.

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